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Nathaniel Clifford Brown.

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IN MEMORIAM: NATHAN CLIFFORD BROWN 1856-1941

BY ARTHUR H. NORTON

Plate 14

NATHAN CLIFFORD BROWN, a Founder (1883), Fellow (1883-1935), and Fellow Emeritus (1936-1941) of The American Ornithologists' Union, was born in Portland, Maine, October 13, 1856, and died in Atlantic City, New Jersey, March 20, 1941. He was descended from two of Maine's most prominent families. His father, Philip Henry Brown, was the son of Hon. John Bundy Brown, who came to Portland from Lancaster, New Hampshire, as a young man and entered upon a most prosperous business career. His mother, Fannie Clifford Brown, was the daughter of Nathan Clifford, jurist, statesman and Associate Justice of the United States Supreme Court.

Nathan Clifford Brown was of frail physique and his occupations through life were subject to interruptions by frequent periods of illness. His early home on Vaughan Street in Portland was on the southwestern part of Bramhall's Hill, an eminence rising to the height of 175 feet above sea level, on an arm of Portland Harbor known as Fore River. Well-kept orchards were on the estate of his father and the adjoining one of his paternal grandfather; on the slope to the southwest was a cemetery of about 15 acres, while to the southeast were characteristic Maine pastures, sloping nearly to the shore of Fore River. Many birds found homes in these orchards and pastures in summer and hosts of migrants paused to rest and feed on the southward-sloping hillside.

This section was Transition in its biotic affinities. At an early age Clifford Brown began to observe closely the numerous birds met in his walks about home, to note their habits and songs and hunt for their nests, which he refrained from disturbing beyond taking a single egg of each species for his collection. His active interest in

egg collecting passed away with his boyhood. He also spent much time at his father's summer home at "Glen Cove" on the eastern shore of Cape Elizabeth which faced the main ship channel leading into Portland Harbor. Here the moisture-bearing winds from the sea favored evergreen woodlands and here a touch of the Canadian fauna was found; Golden-crowned Kinglets, Myrtle Warblers, Juncos and White-throated Sparrows were frequently found breeding there. In spring the migrating birds favoring these conditions followed the patches of spruce woods of the swamps and shores of Cape Elizabeth to that point, to take their departure to the spruce-clad islands of Casco Bay, trending away to the northeastward. Though the ecologic distinctions indicated in his two places of observation were unheralded at that time, he learned to know these avian preferences and to look for his birds in their natural haunts, a store of knowledge of much use to him later in his career. As a youth he ranged rather widely through Cumberland County, of which Portland is the shire town, and the adjoining County of York, on excursions of short duration. At the age of fifteen, in July, 1871, with his younger brother, Philip, and "Ned Blake" he performed a more ambitious journey from Portland to Lake Umbagog in the northern part of Oxford County, a distance of about 96 miles, when the region was little disturbed by the works of man.

On this expedition he first saw the Canada Jay and noted the Whip-poor-will and Bronzed Grackle, two birds not then common in the Portland region. After his return from Umbagog, in the month of August, he did his first shooting of game. An event of the same year, which indicates approval and encouragement for his study of birds was the gift from his parents of the new (1870) edition of "The Birds of New England and Adjacent States" by E. A. Samuels, then the popular manual of northeastern birds. Another step in his ornithological beginnings was his first attempt at taxidermy, when he skinned a chickadee.

In 1873 he entered Bowdoin College (from which he received the degree of A.B. "Causa Honoris" in 1883), but periods of illness interrupted his studies. The following year (1874) he made several rather long journeys when, regardless of their purposes, he seized every opportunity to make observations and notes on some of the birds which he saw. He entered his father's office but it soon became evident that he was physically unable to endure the confinement exacted by this employment. He now, apparently, became confirmed in his determination to make ornithology a pursuit and early in

December (1874), went to Newtonville, Massachusetts, to study the technique of preparing bird skins with the veteran collector, Charles J. Maynard.

In this art he became an accomplished master. From Newtonville he returned to Portland late in January, 1875, and began collecting and preserving specimens in early February. The season appears to have been one when large numbers of Pine Grosbeaks, Red Crossbills, Redpolls and Snow Buntings wintered about Portland, affording abundant material for his work.

In the fall he returned to Bowdoin College, and it was probably that season when, with Robert E. Peary, later Rear Admiral Peary, he engaged a room in Brunswick in which they prepared their specimens.

During the years of 1875, 1876 and 1877 he worked in Maine with occasional short visits into eastern New Hampshire. Though his most continuous and intensive work was in Portland and the adjoining towns in Cumberland County, named in his "Catalogue of Birds of Portland and Vicinity," his operations frequently took him to the adjoining counties of York on the southwest and Oxford on the northeast. An incident of that period, which illustrates the change of sentiment now prevailing in the matter of shooting birds compared with that of half a century ago, was once related by Mr. Brown to the writer. On one of his collecting trips in the town of Deering (annexed to Portland in 1899), he discovered a flock of Red Crossbills feeding in a dooryard. Approaching the house he rang the bell which was answered by a young lady, of whom he asked permission to shoot some of the birds. She smilingly replied, "No objection at all; shoot away." His register shows three specimens of "*Loxia americana*, Deering, Maine, November 30, 1876," which undoubtedly is the date of the incident.

Closing the season of 1877 in November, he turned his face to new fields. The following January (1878), he was at Coosada, Elmore County, Alabama. There he lived with a planter from January 21 to April 30. Returning to Portland in May he continued collecting near home until late in December. During this period he completed the report of his work in Alabama, which was published in two instalments, October, 1878, and January, 1879 (Bull. Nuttall Orn. Club, 3: 168-174; 4: 7-13). Howell says of this report that it was "the first modern list of the birds of Alabama" (1924, Bds. Alabama, p. 11). Among the more noteworthy results of the expedition was the discovery of three and the capture of two specimens of Swainson's Warbler at a time when its habits were very little known, and its

occurrence known only from the island of Cuba and the states of Florida, Georgia and South Carolina, with an unsupported report from Illinois; hence, its discovery in Alabama was an important extension of its established range.

William Brewster, in his illuminating history of the bird, says: "The year 1878 brought an important contribution to our knowledge of the mysterious bird from the pen of Mr. N[athan] C[lifford] Brown, . . . who, after Bachman, seems to have been the first observer to learn anything respecting its habits" (1885, Auk, II: 65). Brown was also the first collector to discover the occurrence of Leconte's Sparrow east of the Mississippi River, and show that it was a rare winter bird in central Alabama.

Late in December, 1879, he began his first season at Boerne, Kendall County, southwestern Texas, where he continued to work until April 3, 1880. There in an arid region, where no fertile plantation invited him, he lodged in the Boerne Hotel, using saddle horses to reach his collecting grounds. Among the results of this season was the discovery of the Rock Sparrow (*Peucaea ruficeps eremoeca*, now generically *Aimophila*), which he described in January, 1882, and an addition to the little knowledge then existing concerning the range and habits of the Golden-cheeked Warbler. Returning to Portland in April, 1880, he resumed collecting in the region and continued until the middle of October.

The year of 1881 was occupied with local collecting, work on the bird collection of the Portland Society of Natural History, where he had been appointed Curator of Ornithology, and the elucidation of various problems of taxonomy in his Texas collection, which had been made at a meeting ground of forms from several different faunal areas. His report was finally published in January, 1882 (Bull. Nuttall Orn. Club, 7: 33-42).

These tasks finished, he resumed collecting in the region of Portland and continued until the end of the year. In December of this year (1882), he published in the Proceedings of the Portland Society of Natural History his 'Catalogue of the Birds of Portland, Maine, and Vicinity.' This was a digest of the records resulting from his twelve years of observation and collecting in the region. Based upon that firm foundation, it stands as a source of reference for the comparison of the bird life of the region at that time with that of the present day.

The following month he returned to Boerne, Texas, for a second season, working from January 27 to April 6, 1883, during which time

he made 15 additions to his first list (of 104 birds), established range extensions, for that time, of the Chestnut-backed Bluebird and Texas Pyrrhuloxia and obtained new information concerning the occurrence of the White-throated Sparrow and Black-chinned Hummingbird in Texas. The report of this work was published in April, 1884 (*Auk*, 1: 120-124). This brought to a close his first period of collecting.

A second period began in December, 1903, and continued somewhat intermittently until 1913. The greater part of this work was done about Camden, Kershaw County, South Carolina, where he made full collections of winter birds, and a less extensive collection of spring and fall specimens in Coos County, New Hampshire.

Throughout his career as a field naturalist, Clifford Brown's aim was to make every specimen perfect according to his high standard of perfection. Perfection rather than quantity was his guide. He loved the objects of his work, admired and appreciated their beauty, bestowing upon them the most painstaking care, coupled with rare skill, in restoring the perfect adjustment of their plumages and life-like arrangement of their patterns of coloration. He collected thousands of specimens, yet neither his prowess as a collector nor his skill as a marksman were ever in evidence in his writings or his conversation; the dead bird was necessary to his purpose but never an object of conquest.

After the close of his first period of work as a field naturalist he lived abroad and travelled extensively in Europe for a decade or more. During the early years of the interim between his two collecting periods, he indulged in literary work, publishing numerous short papers in the literary journals of that time. These gracefully written epics, covering a wide range of subjects, proclaim a sympathetic analysis of human character and a masterful command of language at its best. Many of these articles were published under his own name, but a series of thirteen papers which appeared in the *Portland Advertiser*, stand under the pen name of 'Peregrinus.' Among these contributions may be mentioned one possessing historical value, entitled 'A Glimpse of Modern San Antonio' [Texas], which appeared in two parts in the *Portland Transcript* in November, 1883, under the author's name.

His ornithological papers seem to have begun in 1874, with a short note entitled, "From Maine," in the *American Sportsman*, for December 15, in which he presents records of the Canvasback and Red-head Ducks and the Turkey Vulture, all taken near Portland, an abundance of Pine Grosbeaks, and a brood of Ruffed Grouse

raised that year near his home within city limits, the latter the last known instance of the kind. Of his 104 ornithological titles, 67 appeared in the Bulletin of the Nuttall Ornithological Club and The Auk. His papers were written with great clearness and a pleasing modesty, the author's personality never dominating or even intruding on his subject.

In the scientific organizations in which he held memberships, he took a deep interest, being a helpful constituent and a wise councillor. He was elected to corresponding membership in the Nuttall Ornithological Club in October, 1876; to active membership in the Portland Society of Natural History in June, 1878, where he served as its Curator of Ornithology from January, 1881, to April, 1889, and as a member of its board of managers from 1884 to 1890. He was a Founder of The American Ornithologists' Union in 1883, and a member of its committee to investigate the status of the English Sparrow in North America, in 1884.

His larger collections are contained in the museums of Princeton University and the Portland Society of Natural History. The Princeton collection contains a part of his Alabama series, many of his earlier Maine specimens and most of those of his first Texas collection, including the type series of the Rock Sparrow (*Aimophila ruficeps eremoeca*). Mr. Brown assured the writer that no type, as now understood, was selected by him.

The Portland series is the private collection which he retained until preparing to go abroad; it was bestowed upon the local institution in 1888. This contains part of the Alabama collection, that of his second season in Texas and many of his Maine birds. To this he added part of the collection made in South Carolina.

For many years, Nathan Clifford Brown was unable to indulge in the pleasures and benefits of much reading, yet through the gift of a rare and unfailing memory and an ability to grasp and analyze current events, he kept himself well informed on the history and progress of American ornithology.

He was a man of small, finely proportioned stature, refined, dignified and gracious in appearance; erect in carriage throughout his long span of life. In speech fluent and rhetorical, yet he possessed a keen sense of humor and a merry laugh. Notwithstanding the physical restraint under which he lived, he was always cheerful and his presence was inspiring to the end.

Portland Society of Natural History
Portland, Maine

MATING BEHAVIOR OF THE SAGE GROUSE

BY JOHN W. SCOTT

Plates 15, 16, 17

THE unique, polygamous nature of Sage Grouse (*Centrocercus urophasianus*) society has been little understood, or even suspected. Until less than three years ago, the writer knew only three persons who had seen the act of mating. Many believed the Sage Grouse did not mate. Others, including one ranchman who had seen the birds gather on his place for forty years, asserted that the cocks coughed up the male elements on the strutting grounds while engaged in strutting, and that the hens wandered over the area and picked them up. According to Girard (Univ. Wyoming Publ. 3: 1-56, 1935), many hunters, ranchmen and others believe that the cocks spawn and that the hens pick up this spawn. Such crude explanations are based on misinterpretations of observed behavior. Consequently, the significance of behavior during the mating cycle has been incompletely understood. Under such circumstances, the writer felt it important to investigate the whole mating cycle.

Simon (Auk, 57: 467-471, 1940) has given an excellent and relatively complete description of the strutting and mating performance of the Sage Grouse, and has briefly reviewed the literature bearing on this subject. Our observations in this respect agree closely with those of Simon. The two areas studied are at the same latitude, about 260 miles apart, but differ somewhat in altitude, and the work of Simon was limited to four morning observations, made on April 5, 6, 7 and 8, 1940. Under these circumstances we noted minor differences, as, for example, that mating begins at a later date at the higher altitude, and we could find no evidence that the group of cocks surrounding the hens at a mating spot served to keep the hens together, as suggested by Simon. The differences are chiefly due to the fact that our observations were more extensive and more complete. We carried our study of the mating behavior through an entire mating cycle and worked out the social behavior of the groups of individuals composing a social organization of approximately 800 birds. The remarkable polygamous system that prevailed is described in this paper.

A tent was set up on a suitable spot in a strutting area late in the afternoon before the birds came in, usually between five and six o'clock. All provisions and equipment needed were taken into the tent and the tent was closed. Observation was possible in all directions through a window and flaps in the tent. We did not appear

outside the tent until all observations were complete. This usually occurred between seven and eight o'clock the next morning, but at an earlier hour late in the season. A 16 mm. movie camera with telephoto lenses was used to record significant behavior. Careful notes were kept and the time recorded. Frequently a flashlight was needed to distinguish the time. Later, enlargements were made of individual frames of the movie film to illustrate this paper.

In the spring of 1940, six strutting grounds were located, and twelve nights were spent in the field making observations. In 1941, the largest of these areas was selected for intensive study, and fifteen nights, between March 18 and June 12, were spent in the field, with one additional early morning observation.

YEARLY BEHAVIOR CYCLE

In midwinter, Sage Grouse bunch up in flocks that may include several hundred birds in a single flock. At this season the birds are found on sagebrush areas since the sagebrush leaves constitute their principal food. Both sexes live peaceably together and there is no apparent rivalry among the cocks. With the approach of spring, the mating cycle is initiated and there is an extraordinary change in behavior. This cycle lasts, on the Laramie Plains, from early in March to near the middle of June.

After impregnation during the mating cycle, the hens scatter over wide areas to nest, sometimes in small groups with nests not far apart if cover is exceptionally good, but usually separated widely from each other. After the eggs hatch, the hens with chicks tend to gather in areas where water and small insects are present. The hens lead and care for the young. In early fall, groups are formed, maternal ties are broken and, several weeks later, hens, cocks, and young are found mixed indiscriminately together.

After the mating cycle, the cocks break up into groups of small or moderate size and spend the summer in isolated and remote areas. At this season we have observed no indication of serious rivalry. Early in the fall, the cocks begin to congregate into larger groups and, some weeks later, are joined by the hens and young birds on the winter feeding areas. Such, in brief outline, is the yearly routine.

THE MATING CYCLE

The areas devoted to sexual activity may be termed 'strutting grounds,' since the strutting of the cocks is the most noticeable and characteristic type of behavior on such areas (Plate 15). The size of the strutting grounds varies from an acre to forty or more acres

in extent. The area studied in 1941 averaged over 200 yards in width and was approximately one-half mile in length. At the height of the season, this area accommodated over 400 cocks and a varying, lesser number of hens. The total number of hens visiting the area during the season could not be counted, but probably equalled the number of cocks, according to estimates.

The strutting grounds may be termed 'hereditary' in the sense that the same areas are used year after year. Indeed, the instinct to return to the same location is so strong that a public road passing through one area did not prevent the annual return; some of the cocks strutted on and across the road from where the main body of birds was located. Birds are known to come a distance of several miles. In 1941, some of those that assembled on the strutting area under observation must have travelled a distance not less than four or five miles, possibly seven to ten miles, though there was another strutting ground only two miles away.

Strutting grounds are usually open, flat areas covered with short grass, or open areas on gently sloping hillsides. Nearby sagebrush is usually sparse and low in form. The soil is usually a sandy loam, but may vary from an alkali flat with little grass to an open slope where the small amount of remaining soil is mixed with small rocks and gravel. Three of six areas observed were near water.

At the assemblies early in the season, there is much challenging and fighting, as well as strutting, by which locations are established and dominance is to some extent determined. Strutting by cocks is more noticeable when hens are in sight, but it may also arouse antagonism and result in a challenge to fight a nearby rival. With a warm, open season, strutting probably begins in the latter part of February. It is interrupted and may stop entirely during severe weather. Spasmodic strutting, usually involving only a few birds, has been observed during warm spells in November, December, January, and February.

The number of birds on one strutting ground depends upon the number in the vicinity, the advancement of the mating cycle, the proportion of sexes present, the influence of weather, and the influence of light from the moon. The presence of enemies, particularly the Golden Eagle, may also temporarily alter the number of birds present. The Sage Grouse fears the eagle more than any other enemy, including man. The only other enemy, the coyote, was observed three times on strutting grounds, twice just after daylight, and once at sunrise. Eight cocks were known to have been killed on this area.

Four of these were killed by striking a barbed wire fence that separated two portions of the strutting ground. Another may have been killed in the same way or by an eagle. From the location and appearance of fragments of three others, two were killed by eagles and one by a coyote. One cock that struck the barbed wire was knocked tumbling, but later limped away. Eagles flew over the area nine times on the sixteen mornings under observation, three times one morning.

On the area under observation, some of the cocks began to assemble on the strutting ground early in March. On the cold, gray morning of March 20, after one-half inch of ice had formed during the night, 175 cocks were present; one hen appeared but stayed only a few minutes. On the morning of April 12, 355 cocks and 141 hens were present at one time. A few were observed mating. There were heavy clouds on the morning of April 13, and a fine snow began to fall soon after daylight. At 5:30, with a wind from the north and more than an inch of snow on the ground, 72 cocks and 3 hens were counted. As it snowed harder, the birds began to leave and at 5:55 a. m. the last two cocks walked rapidly away into the sagebrush. On the morning of April 20, there were approximately 350 cocks and 150 hens present. On April 21, a Golden Eagle flew by at 5:04 a. m., and nearly all the birds flew away but most of them soon returned, and a total of thirty matings was observed on this date.

For the next ten days the number of birds varied somewhat with the weather conditions, though there was a decided decrease in the number of hens near the end of April. On May 1, at 4:50 a. m., a count showed 302 cocks and 11 hens. On May 14, there were 174 cocks and 11 hens; on May 21, 238 cocks and 8 hens; and on May 24, 146 cocks and 5 hens. On June 13, two cocks appeared at daylight but left long before sunrise.

Briefly, then, the daily routine during the sexual cycle includes feeding and resting throughout the day, assembling in the late afternoon on the strutting grounds, leaving this area, as daylight fades, for roosting grounds near at hand or at some distance, returning at daybreak to the strutting grounds for the significant, main event of the day, and leaving singly or in groups before seven or eight o'clock for the more or less distant feeding and resting areas.

The daily activity during the mating cycle is, in general, as follows. The hens spend the day in nearby or remote areas feeding and resting. They may be accompanied by some of the cocks, but

usually the sexes are in separate groups. Cocks occasionally do some strutting during the day in the presence of hens. The cocks, as a rule, spend the major part of the day in feeding and resting in widely scattered areas, frequently two or three miles distant, and even farther away. Toward evening, the more virile and dominant cocks gather on the strutting grounds. The time of arrival depends, in part, upon present and recent weather conditions, but lags as the season advances. For example, on April 12 the first cocks arrived at 5:40 p. m.; on the 19th, at 6:27; on the 23rd, at 6:15; on May 3, at 6:50; on May 28, at 7:48. On the same dates, hens first appeared at 6:30 p. m., 7:00, 6:50, 7:30, and not at all, respectively. As soon as the cocks arrive, they take up their accustomed places, strut repeatedly, frequently challenge and occasionally fight a neighboring cock or one that is passing too near. By this sort of behavior, the virile cocks establish a degree of dominance on the area before the hens arrive. Increased strutting is very noticeable when hens are near or in sight. As darkness approaches, the birds leave singly or in groups, though a few cocks may remain until the last daylight fades. At the evening assembly, the number of cocks is only a fraction, never more than one-half, of those present at the morning concourse. It is harder to determine the number of hens present during the evening. I have never seen more than eleven hens in the evening at one time.

At night, some birds may roost in the immediate vicinity of the strutting grounds; others may be found at a distance of two or three miles or more. As the new moon gets higher in the western sky on succeeding days, the additional light influences some of the birds to remain on or near the strutting ground all night. This influence is most noticeable during the last eight or ten days before full moon. At such times, a large number of birds are present, including some hens. Strutting, challenging and fighting activities may occur at any hour of the night. Especially marked demonstrations, lasting an hour or more, have been noted beginning at 10:30 p. m., 11:45; 12:10 a. m., 2:00 and 3:30. At such times, hens have been seen wandering about the area, and the writer is of the opinion that an occasional mating may possibly occur at night, though none has been observed. The fact that no matings occur in the morning until broad daylight suggests, however, that this may not be true.

With the appearance of daylight, additional birds come in and a new demonstration begins that excels all others in magnitude and significant activities. In the number of cocks taking part, in the

volume of sound produced, and in the continuous activities of strutting, challenging and fighting, the maximum activity is reached shortly after daylight and before it is light enough to see a hen clearly at a distance of 100 feet. This is true whether the birds spend the night on the strutting ground or elsewhere. At this time, hens are coming into the area, and a little later, if a cock sees no hen near or approaching, he struts less frequently. However, a cock will continue to defend his station, and strut as a challenge to a rival or for the mere satisfaction of strutting. Occasionally he will stop to look around as if to observe the effect. At or near the mating spots, strutting continues with no respite until well toward the close of the morning assembly or until most of the hens have left the area. Later in the season, with few hens coming in, the cessation of activity becomes rather general after broad daylight, except at the mating spots and in the presence of hens that may be wandering through the area.

When all birds spend the night elsewhere, the first cock usually appears on the area at the first streak of dawn, and begins to *plop*. Within fifteen to twenty minutes, apparently all the cocks have assembled. The earliest morning hours at which cocks were noted appearing were: 3:45 on April 24; 3:45 on May 21; and 3:40 on May 29. As visibility becomes clear, the hens congregate on the mating spots, and the cocks remotely stationed strut less frequently; late in the season, such remote cocks may soon leave the area. However, a large number of cocks remain, and when the hens leave, after mating or after deciding they are not ready to mate, such isolated cocks put on a full demonstration of their strutting ability when hens pass near them. Occasionally, cocks near the outer edge of the area follow departing hens, strutting as they go. In such cases, we have never seen any mating, though the birds were carefully watched until well out of range. A considerable number of cocks always remain for some time after the hens have left the area.

In the morning dispersal, possibly more hens walk than fly away. As a rule, the cocks fly away in groups, occasionally accompanied by a few hens. Judging by the number of birds on the area, some of the cocks probably came from a distance of at least five miles. In dispersing, one group of cocks, observed two miles from the strutting ground, continued its flight for about one more mile.

ORGANIZATION OF THE MATING SPOTS

Dominance in the cocks plays a tremendously important role in the sexual life of this species, certainly not equalled in any other bird with which the writer is acquainted. On the area studied there were four well-defined mating spots, permanently located throughout the season, and each about the size of an ordinary room (pl. 15, fig. 2). At the height of the breeding season, two others were observed. At each of the principal mating spots the following individuals are to be found. (a) A compact group of hens occupying a space that is usually not more than 8 feet wide by 12 or 15 feet long. The number of hens present at first increases and then decreases as the season advances. (b) A master cock that parades back and forth, that struts near or among the hens and undertakes to do practically all matings. (c) The chief rival of the master cock, that is found strutting or standing near at hand and may be called the sub-cock (pl. 15, fig. 3). Under certain conditions, the sub-cock may take over a limited number of matings. (d) A group of guard cocks, usually three to six in number, that serve to keep away intruders which not infrequently attempt to ally themselves with these inner groups (pl. 15, fig. 1). The guard cocks are usually tolerated by the master cock and sub-cock, provided they do not come too close and mingle with the hens. They do a good deal of strutting but seldom do any mating.

In 1941, 174 matings were observed. In twenty cases, the dominance, or rank, of the cock was not determined. Of the remaining 154 matings, 114 (74%) were by master cocks, 20 (12.98%) by sub-cocks, 5 (3.24%) by guard cocks, and 15 (9.78%) by isolated cocks outside of regular mating spots or at hurriedly improvised ones. It should be added that the sub-cock mates only after the master cock has mated with many hens and there is an excessive number of hens ready for mating. The guard cocks have an opportunity to mate only late in the season and after the master cock and sub-cock are surfeited with repeated matings. After the peak of the season is over and near the close of the morning assembly, some hens that are ready for mating but have not been satisfied on the mating spots wander away and mate with cocks on locations outside of a regular mating spot. The conditions under which such matings occur will be described later.

The achievement of dominance by a master cock is not mere accident of location. As a rule the master cocks, sub-cocks and guard cocks are large and apparently older birds; size and weight

evidently are of some advantage. But the master cock is not always the largest cock in the group. He is the cock most ready to fight all comers, the most active, and apparently the most aggressive and vigorous bird. Such aggressiveness is probably determined as much by those internal secretions we call hormones as by age, strength and size. Dominance and winning of location are achieved by fighting, threatening, and bluffing and by the aggressiveness of the cock concerned. The cocks assemble on the strutting grounds once or twice daily some weeks before any hens appear and several weeks before any actual mating occurs. This period is characterized by strutting and those activities that establish dominance. Since the four principal mating spots had (in the present instance) the same general position on the strutting ground as in the preceding year, memory or some sort of conditioned reflex may have a part in determining dominance. The location chosen by an individual cock outside of the mating spots is usually a slight elevation with a level space on which the display of strutting can be easily observed from all directions. Frequently a cock on location has a rival that remains only a few feet away. Between these two, there is frequent scolding and bluffing and occasional fighting, but in general there appears to be watchful tolerance.

In making a threat or challenge, one cock charges or rapidly advances toward another and utters guttural, threatening sounds. If the challenge is accepted, a quick fight may ensue and, after a few blows, one cock may retire beaten. Otherwise the cocks 'square off,' side to side and head to tail, about fifteen to eighteen inches apart (pl. 15, fig. 4). Alert, with body, wings and tail quivering with excitement, both cocks take up the rapidly repeated, guttural challenge. Suddenly a wing lashes out, apparently aimed at the head of the opponent. If not surprised, the opponent may dodge or parry the blow and strike back in turn. A number of blows may be exchanged before they have had enough, and one bird slowly backs away (pl. 15, fig. 5). The victor proceeds to strut, and the vanquished may leave or continue to strut in his accustomed place. In the only instance observed where the beak was used, one cock was holding to the top of the head of another cock and giving him a vigorous, loud wing-beating. The unfortunate cock was trying to pull away, going headfirst. Ordinarily the vanquished cock retreats sidewise or runs away.

Strutting is primarily to express sexual urge and to attract the attention of hens. It may continue vicariously, either on a mating

spot or elsewhere, in the presence of a waiting hen or, early in the season, in the absence of any hen. Secondly, strutting occasionally represents a challenge or the parade of the victor, and may arouse jealousy in another cock and lead to a challenge to combat. The vigorous master cock on a mating spot struts almost continuously, except when actually mating or repelling the advances of other cocks. Much the same is true for the sub-cocks. The guard cocks also do a great deal of strutting, except when engaged in driving off intruders. Throughout the area, all cocks strut almost continuously before it is light enough to see well and, after visibility, whenever hens are near or approaching. In a strut, the cock usually swallows air once or twice and then, with tail spread, head thrown back, and wings tense and partly extended, he advances three or four steps, making approximately a one-quarter or one-third turn, and further inflates the air sacs three times in quick, rhythmic succession. This is followed immediately by an audible, forced expulsion of the air, in which the breast is strongly contracted and the two large bare spots on the breast are rapidly reduced in size until they disappear. Following the audible expulsion of air (almost simultaneously) there is a resounding *plop* (fig. 11 of pl. 16 was taken only three-sixteenth of a second after fig. 9 of the same cock). The cock pauses for a moment to look around and observe the effect and then resumes strutting. A master cock may be so intent on strutting that he fails to observe, or even ignores, a nearby hen that is ready for mating. However, such behavior occurs usually after repeated matings with other hens and may be a sign of sexual satiety rather than lack of observation. In any case, there is no pause in strutting as long as hens are present.

The anatomical mechanism of strutting has not been completely worked out; the following will serve only as a general description. The lateral walls of the esophagus in the cocks are very highly elastic and the air sacs are simply great expansions of this portion of it. The air sacs reach their maximum development during the regular strutting season and are reduced in size at other seasons. The esophagus is muscular as well as elastic, and certain muscles that have their origin on the body framework are inserted on it. The skin over the breast region is highly elastic and muscular. A series of muscles also connects portions of the skin in this region with the body structure. Slow-motion moving pictures indicate that the process of pumping air into the esophageal air sacs involves three forced inhalations and exhalations in rapid succession. It

appears that each inhalation quickly fills the lungs and the air sacs connected with them. This accumulated air is forcibly expelled into the esophagus, during which process the nostrils are undoubtedly closed. During the succeeding inhalation, the opening into the esophagus is apparently at least partially closed, and the air sacs drop to a lower position. After the third inhalation is forced into the air sacs, the air is allowed to escape and, when the wings are raised, there is a strong contraction of muscles affecting the median line of the mechanism and the areas surrounding the bare spots. This results in the rapid contraction or 'swallowing' of the two bare areas on the breast, and their complete disappearance is accompanied by a resounding *plop* (pl. 16, fig. 11).

The head may disappear at the maximum stage of the strut (fig. 12). Note the same bird five-eighths of a second later, after the conclusion of the strut (fig. 13), as a pause is made to inspect the effect. While the air is being forced into the esophagus the wings are down and pressed close as in fig. 8. During an inhalation the wings are raised and partly spread as in fig. 10, taken one-half of a second after fig. 8. Note also the rapid change of position of the air sacs. This up-and-down movement of the air-sac mechanism, followed by the sudden collapse of the air sacs gives a fantastic, grotesque appearance to the strut.

On a still morning the *plop* can be heard for a half mile or more. The quick inhalations may sometimes be heard at a distance of twenty to thirty feet. Early in the season, the third exhalation is usually vocalized, expressed as a whistle-like *purp*. Later in the season, it may be only a sort of soft, whistled *wherch*. After the *plop*, partial deflation takes place automatically, without sound, as the result of the elastic reaction of the involved tissues, which are very much stretched in inflation. Frequently, in deflating, there is a guttural belching sound, and a cock may partially deflate by spasmodic contraction of muscles along the median line, thus exerting pressure on the air pouches. Cocks have been seen to deflate by opening the mouth and stretching the neck, without making any sound.

BEHAVIOR OF HENS

The hens did not appear on the strutting ground in March until two or three weeks after strutting began. They gradually increased in numbers, but no mating was observed until the second week in April. Of 174 matings observed in 1941, 142 occurred from April 20 to April 26, inclusive. It was, of course, impossible to observe



Figure 1



Figure 2



Figure 3



Figure 4



Figure 5

MATING BEHAVIOR OF THE SAGE GROUSE.



all matings. Though a hen may appear on the strutting ground several mornings in succession before mating, one successful sexual union appears to be all that is needed. We have observed a hen mate more than once, but usually late in the season and after a mating of doubtful success. After a successful mating, hens probably do not return to the area. Even during the height of the season, we believe that considerably fewer than half of the hens appearing on any one morning are successfully mated. On the morning of April 12, we saw six matings, when 141 hens and 355 cocks were counted. It was estimated that not more than ten other matings occurred on this date. On May 21, four matings were observed, when 238 cocks and 8 hens were counted. Three matings occurred on May 29, when 146 cocks and 5 hens were present. The breeding season therefore spreads over at least forty-seven days. The cocks appear some four or five weeks before any matings occur, and return for ten days or more after the last matings.

Weather conditions remaining the same, the number of hens at the evening assembly, except late in the season, is rarely ten per cent of those that appear the next morning. The hens appear at the evening assembly fifteen to forty minutes later than the cocks, and leave when the cocks do. At the morning assembly, the hens appear from ten to thirty minutes after the cocks arrive, and leave soon after mating, always in advance of the cocks.

Many hens walk into the strutting ground. Others fly in, but seldom alight in the central part of the area. If ready to mate, they may walk with little hesitation almost directly to a mating spot. Generally, as they walk into the area, they appear to be quite indifferent to the grand demonstration that is put on in their presence. They wander about the area and pause here and there to pick up food; they stop to rest or to look around; sometimes they stop near a cock that seems impressive, but usually go on after a while and show very little interest in the whole proceeding. Such hens may or may not join other hens on a mating spot, depending upon how nearly they are ready for mating. If not ready for mating, they linger for a while, then leave the area to return the next morning.

In general, the behavior of hens on the strutting grounds is inconspicuous and passive (pl. 15, figs. 2, 3). On the mating spots, the hens exhibit a mild sort of 'peck dominance' when in competition for the attention of the master cock. This is especially noticeable when a considerable number of hens are ready for mating. One hen may then drive other hens away from near the master cock.

On one occasion, a hen in an apparent fit of disappointment and jealousy took one vicious peck at a cock, which was not resented. At the height of the mating season, it is not unusual to see fifty to seventy hens standing around in a rather compact group. Early in the season they are more scattered. There is no fighting, and they appear rather unconcerned; 'peck dominance' is seldom seen. Occasionally a hen may preen her feathers or sit down and rest while patiently waiting. If a cock approaches too closely, as if to mate, the hen steps quickly to one side or runs away a few feet. A hen nearly ready to mate shows more interest, and approaches nearer to the path of the strutting master cock; but some time may elapse before she signifies to the cock her readiness for mating (pl. 17, fig. 14).

The behavior of hens on the strutting grounds has been described in different portions of this paper. Briefly summarized, the hens gather in the area later than the cocks, but frequently a day or more before they are actually ready for mating. They wander about the area, apparently little concerned, but actually inspecting the cocks and looking for the location of a mating spot where other hens are present. Here they quietly await their turn, and if not quite ready for mating, soon wander out of the area to return at a later date. If their invitation to mating is accepted by the master cock, they soon afterward leave the area, probably not to return until the following year. If competition is keen for the attention of the master cock, the hens make a querulous *quer, quer, quer*, as if complaining or begging, and one hen may peck at another and drive her away from near the master cock. At the height of the season, if attention from the master cock is not forthcoming, one hen may mount another and even go through the entire act of mating. We have seen as many as four hens in a heap trying pseudo-mating (pl. 17, fig. 17). When a hen comes into the area late in the season and the chief mating spots are no longer continuously occupied, she wanders about as if uncertain what to do, tarries at intervals, apparently looks over several cocks, and may mate with an outside cock or leave the area without mating. In one instance we saw a hen, eight minutes after mating with the master cock, indicate to a second cock twenty feet away that she was ready for mating; two minutes later she left the second cock without mating, went past the master cock to tarry near a third cock sixty feet farther on, and then went on past a fourth cock and out of the area.

BEHAVIOR DIRECTLY RELATED TO MATING

Simon has given a good description of the behavior of cock and hen preliminary to coition. The hen signifies readiness for mating by squatting in front of the cock with outspread wings usually touching the ground (pl. 17, fig. 14). Frequently the wings are fluttered to attract attention. The cock starts forward as if to strut but, instead, steps up on the back of the hen and ordinarily, with head held high, braces himself with his downward extended wings. He quickly brings his tail down, brushing aside the tail of the hen, presses his outspread tail firmly against the ground, thus tilting the body of the female forward, and within a few seconds completes the act of coition (figs. 15, 16). Sometimes the cock remains standing on the back of the hen for two or three seconds after coition is complete. He then slides or steps off and resumes strutting. The hen gets up quickly, runs a short distance and vigorously shakes out and ruffles her feathers. After shaking herself repeatedly, she usually spends some time preening and then marches, or occasionally flies, off the strutting ground, apparently taking no further interest in the area. If the master cock is exhausted by too many or too frequent matings, he may ignore an invitation to mate and go on strutting, or may step up and stand on a hen without making any attempt at coition. At times the hen is covered completely at the sides and rear by the wings and tail of the cock, and in front by the pendulous folds of his breast. On two occasions we have seen a cock seize and hold the top of the head of a hen, as is the manner in domestic chickens. If a hen is approached by a cock when she is not ready for mating, she steps briskly to one side or runs a few steps forward.

The time of day at which mating occurs is interesting and probably is a helpful adaptation for protection against the most dreaded of all enemies, the Golden Eagle. Golden Eagles seldom fly over the strutting grounds before sunrise. Our records indicate that more than fifty per cent of all matings occur before sunrise. On April 21, at 7:40 p. m., just before dark, the movements of a cock observed with 6-power glasses indicated that he was mating with a hen, though the hen could not be seen. On May 20, at 6:17 p. m., a hen was seen to shake out her feathers vigorously, preen herself, and soon walk away, acting as if she had just mated. We have not seen any matings at night. However, such matings occasionally may occur under the influence of the full moon, at the height of the breeding season, but certainly they do not occur often. The presence of a

large number of strutting cocks and some hens wandering about the area, sometimes in small clusters surrounded by cocks, offers circumstantial evidence for this possibility. In the morning, mating does not begin until visibility is clear at one hundred feet or more. Perhaps lack of a minimum amount of light is a factor inhibiting night mating. Mating began on April 20 at 5:20 a. m.; April 21, at 4:42; April 22, at 4:43; April 24, at 4:35. Once started, mating goes on rather rapidly for a time unless disturbances occur.

We have noted that the birds return to the same strutting ground year after year. Barring accidental changes in the environment, like snowdrifts, the mating spots in the area studied in 1941 were approximately the same as those used in 1940. On this large area we have seen only five mating spots in use at one time. The size of such a spot depends upon the number of hens. A mating spot, accommodating sixty-five hens at the height of the season, was approximately ten by fifteen feet. The guard cocks were a few feet outside this area. Sometimes early in the season the hens are more scattered (pl. 15, fig. 1) but mating usually occurs only near the central spot. A snowdrift temporarily dislocated one of these spots. The new location infringed on the territory of adjacent cocks. Some seventy hens gathered on the new location early one morning, but there was so much commotion and fighting that the master cock had great difficulty in repelling encroaching cocks, and had little time for mating. The hens soon began to leave for an adjacent well-established spot about one hundred feet away where there was little fighting, where mating was frequent, and the supremacy of the master cock was not disputed. Within thirty minutes nearly all the hens had deserted the disorderly mating spot.

The social organization of a typical mating spot is fairly well defined, and may be summarized as follows: At the center is a group of hens which, if not immediately ready for mating, stand around quietly in a rather compact group. If a hen starts to leave the group, she is not molested, though some cock may perform a few struts for her particular benefit. If a hen is ready for mating, she usually manages to get near the strutting master cock that dominates the whole group. There are also present the sub-cock, or chief rival of the master cock, and several guard cocks, or cocks-in-waiting, that are subordinate to the other two. Occasionally an outside cock attempts to break into this group; usually he is driven off but, if persistent, he is tolerated a short distance away and so may be added to the list of guard cocks.

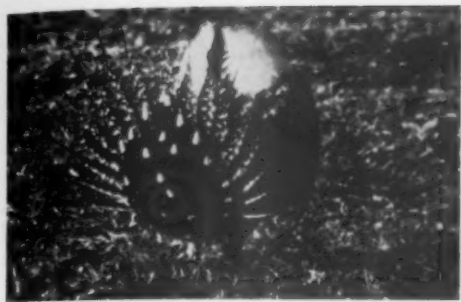


Figure 6



Figure 7



Figure 8

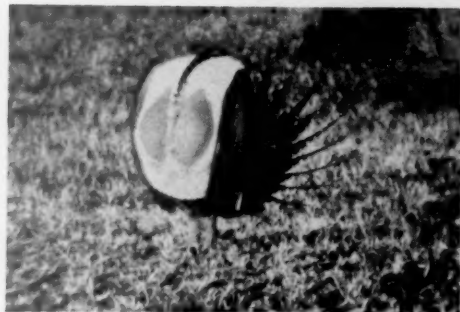


Figure 9



Figure 10

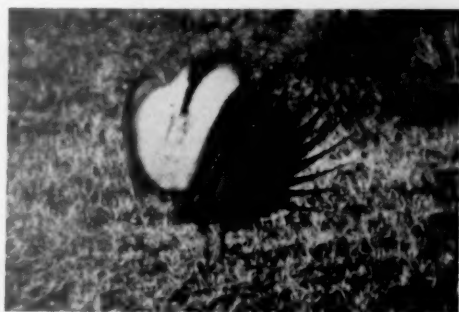


Figure 11

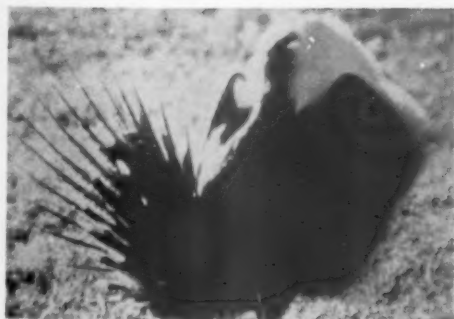
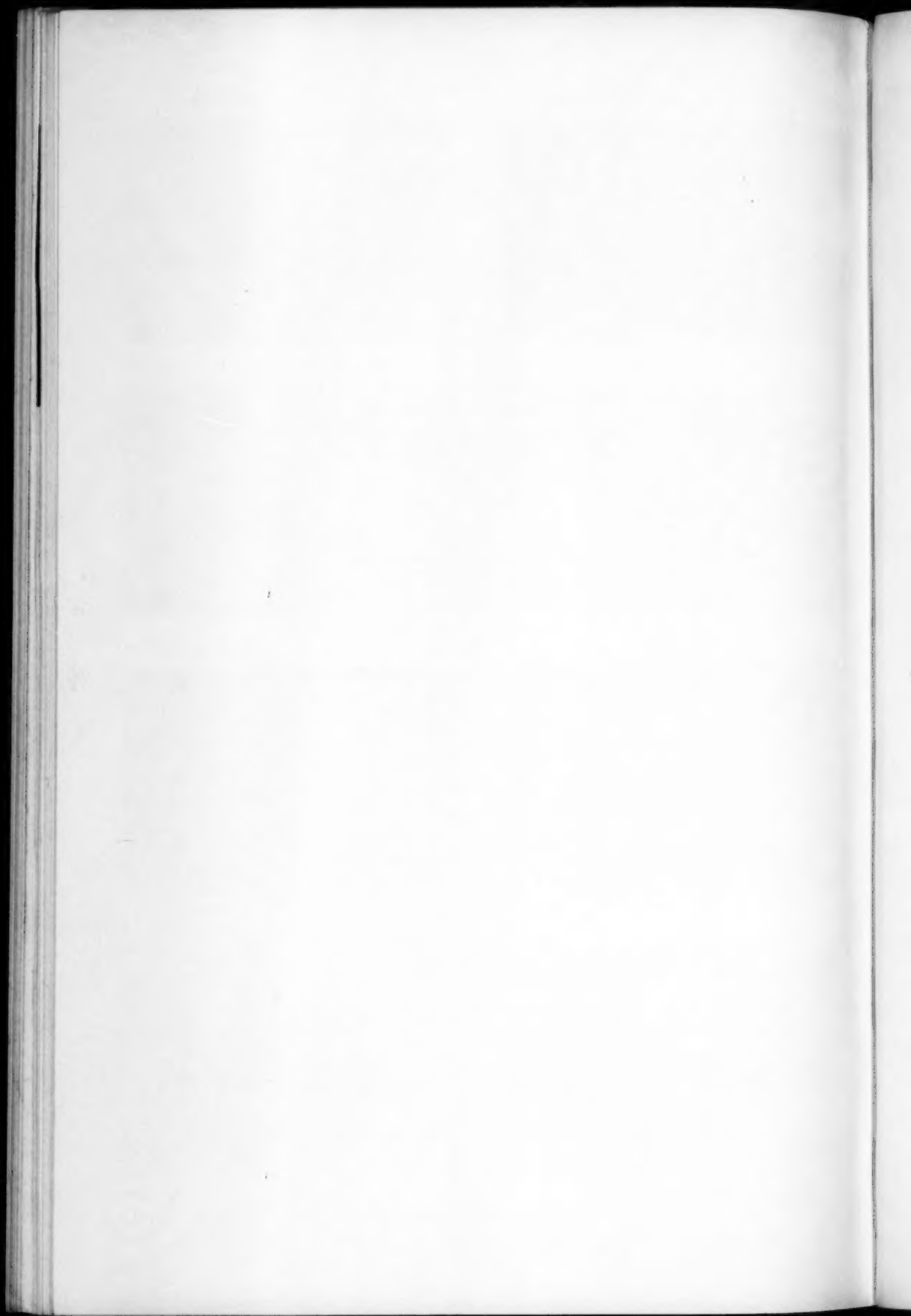


Figure 12



Figure 13

MATING BEHAVIOR OF THE SAGE GROUSE.



The functions of the master cock are: strutting, which appears to be done chiefly for his own satisfaction and for the benefit of the females; fighting and threatening, for the purpose of keeping general control of the other cocks; and, of supreme importance, mating with the hens. The cock, after mating, usually looks around (pl. 16, fig. 13), and if he suspects no intruder, soon begins to strut again. If he discovers a rival (sub-cock or guard cock) near some of the hens, he makes a threatening charge, and if the rival does not give ground, a fight may ensue. Occasionally a cock may become incensed at the sight of another cock in the act of mating and charge fiercely at the mating cock. Sometimes a mating is broken up in this way. On April 20, it was noted that occasionally, when the master cock was busy mating or chasing some other cock away, the sub-cock or a guard cock might mate with a hen near him. Late in the season, the master cock may continue to strut, apparently entirely ignore an invitation to mate, and at the same time fight off other cocks to prevent their mating. On May 21, at 6:46 a. m., a hen signified that she was ready to mate but she was not accepted by the master cock. Again at 6:49 and at 6:51, she was anxious to mate but was again ignored. At 7:00, the hen walked over near the sub-cock and signified readiness to mate, but the master cock attacked the sub-cock and prevented mating. At 7:05 the master cock attempted to mate with this hen, which was then between the two cocks, but he was fought off by the sub-cock. At 7:10, the same attempt was made with the same result. Soon after this, the hen left the area.

The number of matings of which a master cock is capable in a single morning is not known. On April 21, a master cock on one spot mated with four hens before all the birds were frightened away by a Golden Eagle. After the birds returned, the master cock on the same spot mated with eighteen hens. Probably both series of matings were by the same master cock. On April 22, a master cock mated with twenty-one hens. On April 24, a master cock mated with fifteen hens. Mating begins early in the morning, and, once begun, usually proceeds as rapidly as capacity and other duties of the master cock permit. On April 21, a master cock mated five hens in nine minutes (4:42-4:51 a. m.), another mated four hens in five minutes (4:55-5:00 a. m.). On April 22, a master cock mated the first six hens in seven minutes, and the first nine hens in thirteen minutes. Later in the morning and later in the season, mating proceeds more slowly even though many hens are ready to mate.

On April 24, we observed eighteen matings before sunrise, and nineteen matings after it. The earliest mating observed was on April 24 at 4:35 a. m., fifty-two minutes before the rays of the sun fell on the area.

Evidence of sexual satiety or temporary incapacity is indicated by the following observations. One of the cocks mentioned, on April 22, at his eighth mating (in twelve minutes), held his head high and remained on the hen a long time; after the act was completed the hen did not shake herself as is customary after a definitely successful mating. This same master cock, after the thirteenth mating, mounted another hen but did not succeed in mating, apparently due to temporary incapacity. Three minutes later he made another abortive attempt to mate but, on seeing a second hen mount a third one, he immediately deserted the first hen and mounted the second one which slid off the third. He took some time to mate and, while so doing, was attacked by another cock. On April 26, abortive attempts at mating were very frequent after the master cock had made a few matings. On May 11, as early as 4:20 a. m., a master cock paid no attention to a hen that was ready to mate but, instead, fought with a guard cock.

The sub-cock usually accepts the dominance of the master cock. On April 22, a sub-cock mated with his first hen after the master cock had mated with fifteen, and mated with a total of four hens as compared with twenty-one by the master cock. On April 21, a sub-cock mated with a hen on the edge of a group and was attacked by the master cock which up to that time had mated only twice; later the sub-cock attacked the master cock while mating with the thirteenth hen. On April 24, a sub-cock made his first mating after the master cock had mated ten hens. After twelve matings by the master cock, the sub-cock attempted to mate again but was attacked by the master cock. On one spot, on April 26, there were ten matings by the master cock, eight by the sub-cock, and five by guard cocks, the matter of dominance being gradually taken over in the order given. On May 11, as the master cock started his first mating he was attacked by the sub-cock; a few minutes later, after the latter mated, he was attacked by the master cock. This will give some idea of the relative position of the chief rival of the master cock.

The rôle of the guard cocks has been mentioned. They help to keep intruders away from the groups of hens and, as long as they keep a proper distance from the hens, are tolerated by the master cock and the sub-cock. They also tend to take over the mating

when vigilance slackens or when the master cock and sub-cocks are surfeited with mating. On April 26, after the master cock had mated with six hens and the sub-cock with seven, a guard cock attempted his first mating with another hen but was driven away by the master cock. Shortly after this a guard cock mated, but was attacked by the master cock. Later, after the master cock had mated with the eighth hen, a guard cock made a third and fourth mating. Still later when a guard cock started to mate, and again when he mated, he was attacked by both the master cock and the sub-cock. Still later in the morning, when a hen indicated to a guard cock that she was ready to mate, the guard cock was attacked by the master cock.

Under certain circumstances, improvised mating spots may be organized. One morning an eagle frightened all the birds away. After about thirty minutes, when they were coming back, a cock, stationed near the edge of the area, succeeded in stopping five or six hens at his location. He mated with one of these before the others wandered on into the central area. Another improvised mating spot was observed the same morning under similar circumstances, but here dominance among the adjacent cocks had not been firmly established; there was much fighting and commotion and the hens moved on into the central area after one of the hens had mated with an adjacent cock. Late in the season, when hens are not receiving attention on a regular spot, they may wander away to a new, improvised mating spot established by some outside cock. This has been observed three times.

The cocks stationed all over the area outside of regular mating spots spend their time defending their own particular territories and trying to attract the attention of hens coming into or leaving the area. Except for one morning when the birds were returning after being frightened away, as mentioned above, none of these cocks, so far as our observation went, succeeded in mating with hens as they were coming into the area. Usually outside cocks mate only with hens that have not succeeded in being mated on the regular mating spots and as they leave the area. They may or may not pass several outside cocks before mating. On April 24, at 7:57 a. m., the last hen walked away from a mating spot and mated with a cock fifty feet away. On May 9, at 5:10 a. m., a hen indicated to the master cock she was ready to mate, but she was ignored. Five minutes later she left, stopped to linger near two cocks fifty feet farther north, and at 5:16 went on, passed another cock at 5:17, turned

southwest, and at 5:19 mated with another cock one hundred feet from the last. The outside cocks have a subordinate but important place in the social order. Plate 17, figure 20 shows a cock ready to leave the strutting ground, after the morning assembly.

HETEROCLITES

Two to three per cent of the male birds may be termed heteroclite cocks. These heteroclites have about the size but not the full feathering of normal cocks. The form of the body is somewhat between the two sexes. They do not strut and will not fight with other cocks, and they are particularly detested by full-plumaged cocks. When one passes through the area, each stationed cock in turn chases him with such energy that the heteroclite frequently takes to flight. Occasionally one manages to sneak into a group of hens on a mating spot and as he dodges around among the hens, the master cock, sub-cocks and guard cocks frequently have some difficulty in driving him away. On one occasion, we saw one start to mate with a hen, but he was driven away by the master cock. In general, these birds behave more like hens than cocks. Their hormone system is evidently out of adjustment. No attempt has been made to study their anatomy.

From two to three per cent of the female birds may be termed heteroclite hens. These are slightly larger in size than other hens, with the tail somewhat longer than that of the average hen, and the bare spots on the breast are much smaller than those on the cocks but a little larger than those on average hens. On the mating spots they have a decided peck dominance and are frequently active in keeping other hens away from the master cock. At times they will spread the tail and go through all the motions of a complete strut (pl. 17, figs. 18, 19). They are not able to *plop*, due to the relatively small size of the air-sac expansions of the esophagus and the size of the bare spots. At the height of the mating season, when numerous hens are ready for mating, we have seen such a heteroclite hen go through with the complete mating process with another hen; a little later she was mated twice by the master cock. When a heteroclite hen is mated, she is usually not satisfied with one mating but continues to exhibit sexual behavior. Evidently the hormone system of these birds also is out of normal adjustment.

ANOMALOUS BEHAVIOR

This peculiar polygamous system of the Sage Grouse has been remarkably successful in times past when this bird ranged in enor-

mous numbers over an area equal to about one-third of the United States. However useful it may have been in perpetuating the species, the system breaks down at the height of the breeding season when many hens on a mating spot are ready for mating. We have seen three and four hens piled in a heap trying to mate with each other while the temporary incapacity of the dominant cock and the restraint of the system on the other cocks prevented these hens from being mated. As the morning sun rises higher in the sky, the instinct to leave the area transcends all others, and some of these hens fly away unsatisfied. Others may walk through the area and fall temporarily under the spell of an outside cock whereupon nature's chief act is accomplished. In this way the weakness of the system is, in part, compensated.

The pseudo-mating of one hen with another may result in apparent satisfaction to one or both. A master cock was noted looking on while one hen mounted another, but he did nothing. Later the same morning, this master cock again watched a hen mate with another and did nothing. He probably would not have allowed another cock to do this.

The heteroclitcs of both sexes, as previously described, present other types of anomalous behavior. While their behavior may possibly be explained as hormonal or hermaphroditic irregularities or changing sex in some older hens, there are some phases of their conduct that are peculiarly confusing. We have seen a heteroclitc hen engage in the following sequence of acts: mate in the role of a cock with another hen, chase other hens around, strut like a cock, be mated by the master cock, mate with a hen, be mated by the master cock, and mate with a hen,—all within two hours and twenty-one minutes. What the significance of such behavior may be we will not attempt to answer. Such hedonistic behavior does not appear to come within the pale of the system. The following is another example. One morning late in the season of 1940, not twenty-five feet from a regular mating spot, we saw the same cock mount the same hen twenty-two times in the space of one hour. Copulation, or attempted copulation, took place only on the third, fourth, seventh, eleventh, fourteenth, seventeenth, eighteenth and twenty-second starts. This cock was attacked only once by his chief rival that stood near by, though the whole procedure evidently came under the observation of no less than six or eight cocks. Probably no actual copulation took place, for the hen did not act as if mated and so far as we noted her tail was not raised.

Even more abnormal behavior is sometimes shown by cocks. In a few instances we have seen an outside cock mount a dunghill, squat, and go through most of the movements characteristic of actual mating.

UNSOLVED PROBLEMS

This paper has opened up a new chapter in Sage Grouse study and has left many unsolved problems. Does the same cock occupy the same location on successive mornings? We believe that he does, except as he may advance by challenge and contest to a more favorable one; in the new location he probably becomes the tolerated, chief rival. Seldom have we seen a cock driven from an established location, and we have not followed the resulting behavior. Does the same master cock preside over the same mating spot in successive assemblies? Again we believe this is true for the following reasons; we have no direct proof.

(1) On each mating spot there is, as a rule, a rather regular routine; that is, there is a well recognized dominance evident on the same mating spot morning after morning. When dominance is disturbed, confusion and chaotic conditions tend to develop. (2) During the mating season, several large cocks were killed by flying against a barbed-wire fence which separated two portions of the strutting ground, others by eagles, and possibly one or two by coyotes. One morning after a large cock had been killed on the barbed wire, it was noticed that dominance was uncertain on one of the mating spots; previously the behavior on the spot had proceeded in the ordinary fashion. Finally one of the cocks present dominated the area. (3) After a snowstorm, a snowdrift displaced by twenty to thirty feet one of the well established mating spots. This threw the group of cocks in that area out of relative position, for they do not strut on the snow. A large group of fifty to sixty hens collected near the snowbank, but there was so much confusion and the master cock had so much trouble with other cocks that he had little time for strutting or mating. There was also fighting among other cocks. After some time, the hens began to leave and go to another mating spot about forty yards away where dominance was well established and mating was proceeding in regular order.

I have the opinion that shortly after the peak of the season, the master cock, surfeited with much mating, may not return to the area, and that in his absence the sub-cock takes over dominance on the spot. However, there is no direct evidence for this belief. Further work is needed along these lines, as well as to explain the nature of the heteroclites and other anomalous behavior.

We are of the opinion that ordinarily a hen requires only one mating annually. This is indicated by the fact that after an evident successful mating, the hen leaves the mating spot, appears well satisfied, displays no more interest in the area, and soon leaves the strutting ground (pl. 17, fig. 21). Indirect supporting evidence is furnished by the following. Let us assume that the number of hens using this strutting ground equalled the number of cocks (about 400). When we take the number of matings observed each morning and the number of hens present, and allow similar ratios for those dates when no observations were made, the result indicates there were approximately 400 matings on this strutting ground during the season.

After mating, the hens lay no eggs for two or three weeks, and sites selected for nests are very widely scattered. On the contrary, cocks are ordinarily found in groups, usually miles away from the strutting areas. Girard has made some study of the Sage Grouse in summer. Bond (1900), Forbush (1917), Horsfall (1932), Girard (1937), Bailey and Niedrach (1939), and Simon (1940) have added much to our knowledge of the habits of the Sage Grouse. (See Simon, *Auk*, 57: 471, 1940 for references.) If we are to preserve this fine western game bird, an intensive study of the ecological relationships involved throughout the year is urgently needed.

SUMMARY

The mating habits of the Sage Grouse have been studied for two seasons and for one entire mating cycle lasting from early in March to near the middle of June. The strutting ground studied, about one-half mile long and 300 yards wide, accommodated 400 cocks and an estimated equal number of hens. An extraordinary system of polygamy prevailed in which dominance in males was based on fighting, bluffing, and strutting display. Practically all mating took place on five mating spots, each not much larger than an ordinary room. Each spot was occupied by: a more or less compact group of hens; a dominant, master cock that did most of the mating; his chief rival or sub-cock that took over some matings under certain conditions; and several guard cocks surrounding the group of hens that aided in keeping intruders away, and rarely were allowed to mate with hens. The remaining cocks were on widely distributed locations, singly or in pairs. Of 174 observed matings, dominance of cocks was observed in 154. Of this number, 114 (74%) were by master cocks, 20 (13%) by sub-cocks, 5 by guard cocks, and 15 by outside cocks under conditions where the system tended to break

down. Mating took place only upon invitation of the hen. Only the most aggressive, most vigorous, and usually the larger cocks attained the rank of master cock. Both cock and hen heteroclites were observed. Certain types of abnormal sex behavior were noted. Other behavior and correlated habits are briefly described.

EXPLANATION OF FIGURES

- Plate 15, fig. 1. Loosely dispersed mating group early in the season. Hens, master cock (R. Center), sub-cock (L. Center), three guard cocks, other scattered cocks.
2. Master cock and twenty-two hens.
3. Master cock strutting; sub-cock and thirteen hens.
4. Cocks in fighting position.
5. Cocks fighting.
- Plate 16, fig. 6. Cock strutting, rear view.
7. Cock strutting, side view.
8. Forcing air into esophagus; wings low and close to body.
9. Maximum inflation.
10. Drawing air into lungs and air spaces, one-half second after fig. 8. Compare altered position of wings and air sac.
11. Deflation (just after *plop*); three-sixteenths of a second after fig. 9. Note disappearance of bare spots.
12. Head of cock may disappear at maximum phase of strut.
13. Five-eighths of a second after fig. 12. Cock pauses to look around.
- Plate 17, fig. 14. Hen signifies readiness for mating and is accepted by the master cock; sub-cock nearby.
15. Mating, side view. Head of hen may be seen.
16. Mating, front view.
17. Two hens mounting a third.
18. Heteroclite hen strutting.
19. Heteroclite hen, strutting. Compare size with master cock and other hens.
20. Cock resting after hens have left; about ready to leave.
21. Hen ready to leave strutting ground.

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Figure 14



Figure 15



Figure 16

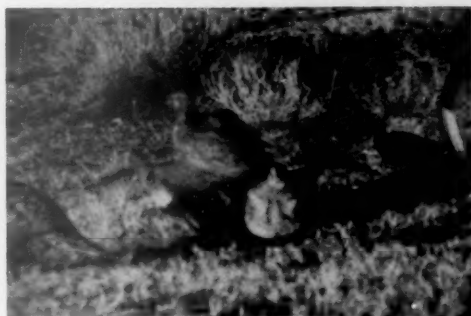


Figure 17



Figure 18



Figure 19



Figure 20



Figure 21

MATING BEHAVIOR OF THE SAGE GROUSE.



ANNUAL CYCLE OF THE BLACK-CAPPED CHICKADEE-3

BY EUGENE P. ODUM

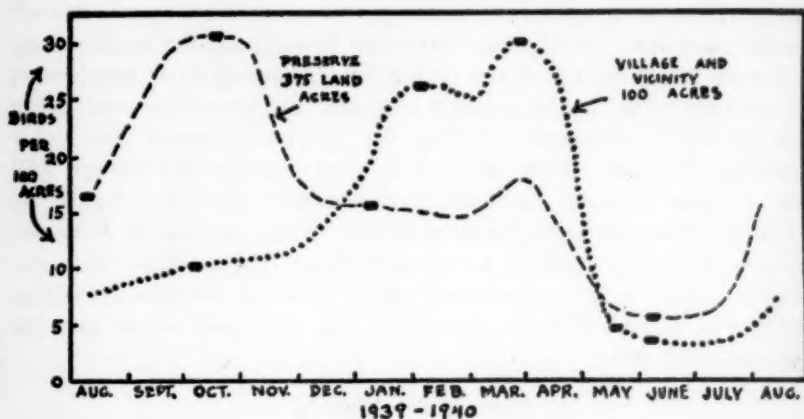
THE two previous parts of this paper (Auk, 58: 314-333 and 518-535) were concerned with the activities of Black-capped Chickadees (*Penthestes atricapillus atricapillus*) on the Huyck Preserve and vicinity during the breeding season, which, in one phase or another, covered nearly half the year from March to August. The present and concluding part deals with the non-breeding half of the year, in which a study of flocking and general behavior received special attention. Much time was spent throughout the autumn and winter in following the flocks in the field, charting their movements on mimeographed maps, making censuses, and recording everything that could be observed. During the winter, trapping and color banding were carried on at four stations, two in the village and one at each end of the elongated Preserve (see Text-figure 3). No feeding stations were operated in the central part of the Preserve, an area left as a 'control' without artificial feeding (nor were stations operated here in previous years). One of the winter village flocks was singled out for special day by day observation and for experimental work.

POPULATION TRENDS

In analyzing autumn and winter behavior it is important to consider the seasonal changes in population which are summarized in Text-figure 2. The data on total populations previously given are here reduced to a common figure of birds per 100 acres (or 40 hectares). Also, these data refer to density in the total land area including all habitats (see Text-figure 3); at certain seasons chickadees frequented all parts of the study area, while in summer they were more restricted in regard to habitat. Each rectangular point on the graph represents the population density at a specific time of year as determined by a series of censuses of the entire areas and by banding. The broken lines connecting the points are the partly hypothetical trends which were believed to have occurred as evidenced by movement of banded birds and by censuses over parts of the areas. The curve as a whole, therefore, pictures in a diagrammatic way the major seasonal changes in population which occurred during the year. Population was most stable during mid-winter and early summer when the great majority of individuals remained within restricted areas; hence, population could be more

accurately determined during these fixation periods. At other seasons, particularly late summer and autumn, the population was not only larger but many individuals were not fixed in their movements; hence, population was more variable and more difficult to determine on a comparative basis.

The important points to note from Text-figure 2 are: (1) Population on the Preserve (essentially a natural upland wooded area) was greatest during late summer and autumn while a peak was reached in the village (an area of shade trees, shrubbery and feeding



TEXT-FIGURE 2.¹—Seasonal variation in the Chickadee population of the Preserve as compared with the village vicinity. See text for explanation.

stations located in the valley) during the winter. (2) In both areas the population was greater in winter than in summer, but the difference was more marked in the village, the winter-summer ratio being approximately 2.5 to 1 on the Preserve as compared with 8 or 10 to 1 in the village vicinity. These relations suggest that there may be a well-marked seasonal movement from forested hills and swamps to settled valleys and other places of winter concentration; this was also indicated by the dispersal of birds from the village to the surrounding country which was actually observed in the spring. Much has been written concerning the migratory status of the chickadee in the Northeast and the various lines of evidence have been recently summarized by Wallace (1941). Most of the evidence, including banding results in the present study, boils down to the following: (1) Adults tend to remain fixed during both

¹ Text-figure 1 appeared with Part 1 of this paper in *The Auk*, 58: 316, July, 1941.

winter and summer but may (or may not) move at least locally during the spring and autumn; (2) Immature birds of the year range widely and apparently irregularly during late summer, autumn, and perhaps to a lesser extent during winter and spring, rarely remaining in or returning to the area of their birth. Therefore, a given chickadee flock may contain a relatively stable element,—the local adults,—and/or a relatively unstable element, the first-year birds. These relations, together with the expected population increase following the breeding season, seem adequate to account for a population curve such as shown in Text-figure 2 and to clarify certain aspects of flock behavior.

For comparison, a few estimates of the abundance of chickadees in other localities are listed below, although few attempts have been made to determine the year-round picture.

Reference	Area	Locality	Birds per 100 acres	
			winter	summer
Butts (1931)	1 sq. mile semi-wood- ed country	Ithaca, N. Y.	20	4.7
Butts (1931)	80-acre Fuertes Sanctuary	Ithaca, N. Y.	38	5
Williams (1936)	65 acres climax beech-maple	Cleveland, Ohio	24.6	12.3
Forbes and Gross (1923)	58 acres open woodlands	Northern Ill.	10.3
Bird (1930)	Aspen forest	Manitoba	6.2
Van Deventer (1936)	Mendon Pond Park	Western N. Y.	19.5
Saunders (1936)	Beech-maple, oak- hickory, cherry- aspen forests	Allegheny State Park, N. Y.	9.4

Wallace (1941) reported the lowest winter population in three years of study at Lenox, Massachusetts, during the winter of 1939-40, but does not give figures in terms of population per unit area.

VOICE

Vocal activity is extremely important in regulating the behavior of chickadees, especially during the flocking season. Like the Corvidae, chickadees have a large vocabulary. Many, if not most, of the notes seem to have definite functions, that is, they are given under particular conditions and frequently produce definitely observable responses. The following are those which the writer has been able to distinguish clearly. The list does not by any means cover all the utterances made by the species. Variations and intermediate

notes are sometimes heard which on further study may prove to have special functions. Some of these notes have been mentioned previously in this paper but all are listed here for completeness.

1. *The phoebe song*.—A high-pitched clear whistle of two or three notes, *phoe-be* or *phoe-be-be*, uttered by both sexes but more frequently and louder by the male. The *phoebe* song was heard sparingly throughout the year but most often in the spring during pre-nesting activities. As previously discussed, loud songs given by males function in courtship and in territory defence. In late summer and early autumn a hoarse, sometimes imperfect whistle is given extensively by juveniles. During the autumn and winter the song was rarely heard, although on several occasions whistles were given just before birds went to roost. I have noted that the same individual may change the pitch of the whistle or change from two to three notes as Saunders (1935) has described.

2. *The signal song*.—Exactly like the regular song but much softer and sometimes reduced to one note. This much subdued song is given by the male (rarely by the female) when approaching the nest. Either sex may give soft whistles under conditions of excitement as, for example, when the young are leaving the nest.

3. *General call note*.—The familiar *chick-a-dee-dee-dee* is uttered by both sexes throughout the year, but most frequently during the flocking period. Use of this note seems to announce the whereabouts of the bird to others. When one bird becomes lost from the flock, or the flock becomes scattered, this note is frequently given with the result that the flock tends to consolidate again. The same was observed when members of a breeding pair became separated in feeding excursions. There are a number of variations of the chickadee call, some of which have special meanings as listed below.

4. *The scolding note*.—A loud, rapidly given *chick-a-dee-dee-dee-dee* with emphasis on the *dee* part. The scolding note is similar to the general call note but easily distinguishable by the more emphatic tone and lower pitch. This note is heard when the nest is attacked or an enemy such as a cat or an owl is sighted. Other chickadees or species respond by coming up to scold or attack the enemy.

5. *The fighting note*.—A sputtery, high-pitched, beady *chick-a-dee* or *chit-chit-chit* (repeated a varying number of times). This note was frequently heard during spring 'fights' between pairs and during the chasing and fighting phases of territory defence. The note seems to indicate a higher degree of emotional stress and anger than no. 4.

6. *The alarm note*.—An explosive, short *chick-a-dee* or *chit-chit*.

This note is given when an enemy appears at close quarters or attacks suddenly, especially if the bird is feeding on the ground or in the open. The alarm note is usually accompanied by a dash for cover; other birds following the example. Thus, this note, although similar to the above, produces the opposite reaction and seems to express fear rather than anger.

7. *The recognition or contact note.*—A thin, weak *tseep* or *tseet* is the most frequently uttered note in the vocabulary, heard at all times of the year from both sexes. The contact note is uttered more or less continually and seemingly automatically by birds in the flock and by mated pairs, especially during feeding excursions. Single birds may also give the note, but presence of companions results in increased frequency. It was noted that the frequency of *tseep* calling decreased in very cold weather, when birds were resting or preening, and when engaged in feeding the young. The *tseep* call seems to serve to keep birds in close communication with each other.

8. *The flight or restless note.*—A thin, weak *tsleep* or *tsleet* somewhat higher-pitched and louder than the contact note, and usually easily distinguished from it. This note is uttered just before extended movements or flights across open spaces. Usually one can safely predict that the flock or individual is going to move from one place to another when this note is heard. In the flock, after one bird calls repeatedly, others often follow suit and the flock moves as a whole.

9. *The warning note.*—A thin, very high-pitched *tsee* repeated several times. This note may follow the alarm note when a hawk attacks, or more frequently it is given without the alarm note when a hawk appears or any large bird flies over or casts a shadow. Chickadees and also other species (warblers, kinglets, etc.) respond to this note by 'freezing,' that is, remaining perfectly motionless. In the case of a hawk or shrike attacking, the birds may remain 'frozen' for as long as ten minutes and can almost be touched before they will move. When the bird causing the warning is a crow or a woodpecker, chickadees 'freeze' momentarily or not at all. The 'freeze' is usually broken when one bird calls *chick-a-dee*; almost immediately the flock becomes active again. I have never heard the warning call given at the approach of an enemy on the ground; it is apparently specialized for winged enemies.

10. *The dominance note.*—A throaty *che-lùp* or *che-ùp-che* which may be given by either sex but most often by aggressive males. This note is apparently a 'vocal threat' used when birds come close together or when one bird chases another. It is frequently heard at feeding

stations when two or more birds attempt to feed at the same time; a dominant bird may put to flight a subordinate bird simply by using this note. The dominance note is also given under natural conditions when one bird displaces another, and along with other notes during courtship and territory quarrels.

A number of gurgling, semi-musical notes have been heard which are apparently variations of the dominance note. These were given particularly in the spring and by juveniles in late summer without being directed at another bird or producing an observable response. If anything, they apparently express a condition of general vigor.

11. *A musical to-will.*—This call was frequently heard during the spring and during the flocking period, often in connection with calls nos. 3 and 10. However, its function was not evident.

12. *The begging note.*—A loud *tee-ship* or *tee-ship-she*, given by young from the time they leave the nest until independent of the parents, and by the female during egg laying and incubation (more rarely at other times during breeding season). Begging by both young and the female is often accompanied by a fluttering of the wings.

13. *The mating (?) note.*—A high-pitched, rolling twitter accompanied by fluttering of wings. This note uttered by the female was heard just before and during copulation and also during ceremonies preceding pairing in one case. This note with wing-fluttering accompaniment was also frequently given by both sexes when the pair met close to the nest.

14. *The 'perplexed' note.*—A very low guttural sound given by the adults when some strange object or person was near the nest. When birds gave this note they appeared to be puzzled rather than alarmed.

15. *The 'hissing' or 'bluff' note.*—Rather the result of a forced expiration than a vocal effort. Incubating females and nestlings between the ages of 12 and 17 days sometimes puff up and 'hiss' at the intruder when the nest is approached closely, as Thoreau has described.

16. *The distress call.*—A loud squeal similar to the distress call of a baby chick. I have heard this only from nestlings which had been captured after leaving the nest. The call released notes nos. 4 and 5 together with injury-feigning behavior on the part of the parents.

Many of the above chickadee notes do not seem to be generally recorded in the literature. Thus, Forbush (1929) lists only four notes (nos. 1, 3, 10 and a rare "singing like a ruby-crowned kinglet" which I have not heard), and Saunders (1935) likewise lists four (nos. 1, 3, 7 and 10). However, comparable notes have been described for other species. Davis (1940) lists thirteen notes for the

Smooth-billed Ani (*Crotophaga ani*), a markedly social species, some of which are comparable in function to chickadee notes. The Ani, for example, has a different note (*and different accompanying behavior*) for a hawk and an enemy on the ground. Erickson (1938) lists a dozen or so notes for the Wren-tit (*Chamaea fasciata*), most of which have corollaries with the chickadee notes. Hann (1937), on the other hand, lists but four or five call notes (other than songs) for the Oven-bird (*Seiurus aurocapillus*), generally a non-social species.

Many of the chickadee's notes, although sometimes having very different functions, have apparently developed from a given type of vocal utterance. Thus, notes nos. 1 and 2 are *phoebe* notes; nos. 3, 4, 5, and 6 are variations of the *chick-a-dee* call; nos. 7, 8, and 9 are *tseet* notes. Also, the same note may have different functions at different seasons (no. 1 and probably 10). Consequently, variations of a few basic notes give the chickadee a considerable means of vocal communication. Of the sixteen notes listed, about eight are concerned primarily with breeding behavior and eight function primarily in general social relations.

The part that these notes play as 'signals' (Tinbergen, 1939) or 'releasers' (Lorenz, 1935, 1937) is evident from the above descriptions. Lorenz (1937) lists six releasing functions of the social companion; it is interesting to note that the chickadee has a call note which functions in five if not all six of these as follows: (1) inducing 'contagion' or 'imitation,'—perhaps call note no. 8; (2) the release of following reactions,—notes no. 3 and 8; (3) response to warning,—no. 6 and 9; (4) social attack reactions,—no. 4; (5) pecking-order reactions,—no. 10; (6) response to disappearance of a companion,—no. 3. Thus, chickadees, perhaps more than larger or more conspicuously plumaged birds, depend on stimuli in the acoustical rather than the optical field in synchronizing the activities of the flock members.

FLOCK BEHAVIOR

Chickadee flocks are rather loose aggregations of individuals; occasionally the flock is fairly compact and moves with a fair degree of precision, but usually it is a straggling affair. When a flock crosses an opening, for example, birds pass over singly or in twos or threes and it may require ten minutes before a flock of a dozen birds passes from one side to the other. Abundant observation has convinced me that the chickadee is a strong individualist but at the same time has considerable social tendencies during non-breeding periods; consequently, its flocking tendencies are intermediate between

those of strictly non-social species and of such a highly social species as the European Jackdaw in which the flock is well organized and behaves as a 'super-individual' (Lorenz, 1935).

Size and individual composition of the flock.—The number of birds in a flock is often difficult to determine, especially in thick woods. However, by keeping slightly ahead of the flock as it moved it was frequently possible to obtain accurate counts of the birds as they passed across openings in the forest, crossed roads, or moved along hedgerows. Such counts of flocks in the woods together with counts of banded birds at village feeding stations may be summarized as follows:

	Number of observations	Average birds per flock	Variation
Autumn (Sept. and Oct.)			
Natural flocks on Preserve	33	8	2-20
Winter (Jan. and Feb.)			
Natural flocks on Preserve	16	7	2-16
Village feeding stations	20	12	8-16

Single birds seen every now and then in both autumn and winter are not included in the above averages. Two things of interest seem to be indicated by these data. First, although the population was largest on the Preserve during the autumn, flocks averaged only slightly larger (however, the largest flocks were recorded during this season, these being counterbalanced by small flocks also frequently encountered). In other words, the larger autumnal population resulted partly in larger flocks but mostly in more numerous flocks as was also observed in census work. For example, a rapid cruise of the Preserve on October 19 revealed seventeen flocks, while on January 10 but seven flocks could be located. Secondly, the flocks around feeding stations in the village were larger than those occurring under natural feeding conditions.

Wallace (1941) reports that the 'standard' chickadee flock at Lenox, Massachusetts, is six to eight individuals in winter, which is approximately the same size of flocks reported by W. P. Smith in Vermont and by Whittle in Massachusetts (see Wallace, 1941). Butts (1931) considered the number in a complete flock to be about fifteen on his study area at Ithaca, New York. He did not believe the abundant feeding stations present had any effect on the number of birds although he had no control area (without feeding stations) to test this assump-

tion. Both Wallace (1941) and Mrs. F. N. Hammerstrom (1942), on the other hand, report that good stations operated over several years may build up a large patronage. As Wing (1941) has pointed out, groups of birds held together by a common attraction of the environment (concentrated food supply or limited habitat, for instance) should probably be considered 'congregations' rather than true flocks in which birds associate because of a gregarious urge.

While seven or eight is apparently the average-sized natural flock at this latitude this average has more of a theoretical than actual significance for two reasons: (1) flocks of four to five or ten to fifteen are as frequently encountered as groups of seven or eight. (2) A flock is not permanently fixed in size, but may vary from day to day or even from hour to hour. Even in winter when most individuals remain within remarkably limited ranges flocks break up and re-form or individuals pass from one flock to a neighboring one as is readily observed when flocks are followed for long periods of time. Frequently, individuals or several individuals were observed to lag behind or become detached from the flock. Usually, much calling back and forth resulted as if the birds were torn between the desire to follow the flock or to have the other birds follow them! Sometimes one or the other of the detachments would 'win out' and the flock would consolidate; at other times the two portions would remain separate, perhaps to join later. The following observation condensed from field notes indicates how contact by separate flocks may influence composition of the flock:

February 1, 7:05 to 9:30 a. m.—Follow chickadee flock in Lincoln Pond woods from time of leaving roost. Accurate count at 9:28 shows eleven chickadees present. 9:57.—Another flock comes from northern part of woods and two groups join after much calling and milling around. 12:00.—Large flock still intact, birds feeding in hemlock trees; count shows 27 chickadees present. 12:55.—Flock splits, one group moves rapidly north, the other south. Accurate count shows fourteen birds in south group, apparently three birds from north group have joined the south flock at least temporarily.

The study of banded birds in winter showed that some individuals had a greater tendency to become detached from the flock or to pass from one area to another than did other individuals. In the autumn with numerous unsettled juveniles, this variation is probably even more marked.

Chickadee flocks do not seem to have definite leaders, which may have some bearing on the partial instability of the flocks. Birds seem to follow first one individual then another. Probably they tend to follow the individual which acts or calls most forcibly, or

as Lorenz (1935) comments, that individual which 'knows what he is about.'

To sum up, factors which result in partial instability of the flock are: lack of definite organization or leadership within the flock, individualistic tendencies of the birds (see subsequent discussion of dominance), and tendency of some individuals to wander especially in late summer and autumn. On the other hand, factors which tend to keep the flock intact are: social or gregarious tendencies of the species, strong development of vocal signals, and strong tendency of many individuals to remain in a restricted area. Apparently, a counterbalance of these tendencies results in the usual small-sized flock. Thus, the larger the flock, the more apt it is to split up; likewise, the smaller the flock the more apt it is to join with other birds provided there are others in or near the cruising range. Where chickadees are scarce the flocks will, of course, be small. As already pointed out, large groups of birds around feeding stations may be congregations rather than true flocks. Very large flocks, however, have been reported during migration or emigration of birds in the northern part of the range (see Butts, 1931).

It should be pointed out that territorial behavior, that is, defence behavior on the part of individuals of the flock, does not seem to play any part in determining the size of the flock. Although social-dominance reactions occur, birds during the non-breeding season do not attempt to drive other individuals from the vicinity. New birds are readily accepted in the flock although they may be relegated to a low position in the dominance order (Odum, 1941).

R. C. Miller (1921, 1922) has described the flock behavior of the Coast Bush-tit. (*Psaltiriparus m. minimus*). Flocks of this species apparently have a loose organization very similar to that of chickadee flocks, although Bush-tit flocks are larger—up to 70 individuals. The behavior of Bush-tits when attacked by a hawk is quite similar to that of chickadees; the notes uttered by the Bush-tits, which Miller calls the 'confusion chorus,' corresponds to the 'warning' call described above.

Movements of the flock.—As previously indicated, flocks were followed in the field and their movements plotted on base maps. A study of sixteen such maps (each map representing an observation period of two hours to all day, averaging four hours and totaling 63 hours) involving movements of natural autumn and winter flocks (no feeding stations present) brings out the following (the figures given represent the movement of the flock as a whole as measured from field maps and not movement of individuals):

1. The average rate of movement of chickadee flocks was 1425 feet per hour (about one-quarter mile per hour). Movement, however, was not uniform but more or less rhythmic; periods of fairly rapid movement (one-half to three or four miles per hour) with little feeding were alternated with periods of little or no movement when birds were actively feeding. Active feeding periods varied from three to thirty minutes; active moving periods were generally of short duration, two to ten minutes.

2. The rate of progression was generally greater in the morning than in the middle of the day. Flocks definitely moved slowest on cold and especially very windy days (600 to 1000 feet per hour) and fastest on warm, cloudy days (2000 to 2700 feet per hour).

3. The average rate of movement between August 28 and September 13 (24 hours observation) was 1042 feet per hour; between October 10 and November 2 (23 hours observation), 2037 feet per hour; and between December 11 and January 31 (15 hours observation), 1482 feet per hour.

4. Chickadee flocks did not move in any one direction for very long but tended to double back and forth in an irregular manner and consequently to restrict themselves to an area of fairly definite limits, especially in winter.

5. No regular routes were followed by the flock in the movements over an area as Butts (1931) noted, but there were favorite feeding places (such as a hemlock tree loaded with cones) which were visited repeatedly. Thus, some parts of the feeding range and certain routes were utilized more often than others.

The three all-day observations summarized below are of special interest. On each of the three days a flock in the same area (vicinity of range 8 in Text-figure 3) was followed from 'roost to roost.'

Date	September 13	October 26	January 31
Weather	Clear	Cloudy	Cloudy
Temperature (F.)	65-75°	56-62°	15-26°
Number chickadees	9±	10±	11±
Number other birds regularly associated	20±	15±	0
Movement of flock in feet per hour	1087	2037	1744
Total area covered by flock in acres	9.3	34.9	24.2

From these data it would seem that the rate of movement of the flock was roughly proportional to the area covered. If so, the cruising range of the flock tended to be greatest during the population peak

of October, and greater in winter than in early autumn. This was also correlated with seasonal variation in habitat selection. Late-summer flocks generally remained in the woods, while October flocks were observed in all parts of the study area, even invading the abandoned weed-covered fields. In winter, birds occurred in a wider variety of habitats than in summer but not to such an extent as in the autumn. In the all-day observations the flock on October 26 spent about a third of the time in the fields and hedgerows to the east of the woods, whereas on the two other days the flock ranged entirely within the forest and forest edge.

Interspecific relations.—Little attempt seems to have been made to determine whether the commonly encountered mixtures of chickadees and other species are true flocks,—birds held together by social bonds,—or merely congregations resulting from similar habitat or food attractions (see Wing, 1941). Butts (1931) states that the association of chickadees with nuthatches and other species is a temporary one, but his statement applies only to the winter season at Ithaca, New York. Van Deventer (1936) observed two or more of four species—Chickadee, White-breasted Nuthatch, Downy Woodpecker, and Tree Sparrow—associated 31% of the time or more than could be accounted for by chance, but this association seemed to be primarily the result of habitat since all four were partial to the forest edge.

In following the chickadee flocks, special attention was paid to the associated species. If individuals of other species remained with chickadees constantly as the latter moved from place to place or from habitat to habitat they were judged to be a true part of the flock. If, however, other birds readily separated from chickadees they were judged to be largely independent. Using this criterion, the following generalizations can be made from observations in this particular locality. First, chickadees did form true, even though more or less temporary, flocks with certain species, chiefly transient warblers, vireos, and Ruby-crowned Kinglets in the autumn (and to a slight extent in the spring). Individuals of these species were closely associated with chickadees and remained with them throughout their movements. Secondly, other species were frequently associated in varying degrees with chickadees during autumn and winter, but not generally on a true flocking basis. To illustrate more specifically, species or species-groups are listed below in the approximate order of their tendency to flock with chickadees:

1. Arboreal warblers and vireos (particularly transients).—Chickadee-warbler flocks were a characteristic feature of the woods during

August and September. These flocks were often large, up to 50 or 100 individuals, which moved as a loose but definite unit. Chickadees as a species were definitely the leaders since warblers followed them rather than vice versa; the chickadees were much the noisiest and by their vocal signals seem to control the flock. Mayfield (1937) recounts a similar observation in middle Tennessee where Carolina Chickadees and Tufted Titmice share in the leadership of mixed autumnal flocks and determine the area to be covered and the rate of travel. Warblers and vireos react quickly to many of the chickadee's signals particularly the warning 'freeze' call. Many times attacks by accipitrine hawks were observed to fail completely because the warning calls of alert chickadees instantly 'froze' the entire flock before the hawk could get within striking distance. Undoubtedly, having chickadees as local escorts is of survival value to the transient warblers.

The way in which the chickadee-warbler flocks may form was dramatically illustrated by actions observed on September 13. Before dawn the contact or recognition calls of numerous warblers were heard just above the treetops, as the birds were evidently coming in from a nocturnal migration flight. For about an hour after dawn, warblers were observed all over the thirty-acre tract of wood; the birds were moving rapidly through the treetops and were calling loudly. A little later in the morning, however, the situation was entirely different; all the warblers had joined one or the other of the two chickadee flocks in the woods and were now largely silent.

Species of warblers most commonly flocking with chickadees were: Chestnut-sided, Magnolia, Black-throated Green, Black-throated Blue, Blackburnian, Canada, Redstart, Black and White, Black-poll, Bay-breasted, and several less common species. Red-eyed and Blue-headed Vireos also were strongly associated. Terrestrial warblers such as Oven-birds and Water-Thrushes did not flock with chickadees. Also, Myrtle Warblers, passing through later, were largely independent, tending to form their own flocks in more open habitat. Immature warblers began following chickadees when the first flocks formed in July. It is interesting to note that a family of Black-throated Green Warblers, in which parents were still feeding the young in August, failed to join chickadees but remained within a much smaller area.

2. Ruby-crowned Kinglet:—In October and early November, after most of the arboreal warblers had departed, the Ruby-crowned Kinglet replaced them as constant companions of chickadees. Although generally not so numerous as warblers, kinglets followed chickadees

almost as closely, and were even observed to roost in the same evergreens.

3. Red-breasted Nuthatch:—This species showed a strong tendency to flock with chickadees, but the association was limited by a still stronger habitat-preference since this nuthatch is very partial to coniferous woods. Thus, as long as chickadees remained in hemlock woods the Red-breasted Nuthatches flocked with them, but when chickadees passed into open territory or deciduous woods the nuthatches did not follow.

4. White-breasted Nuthatch:—These nuthatches exhibited a moderate degree of sociability with chickadees, sometimes following flocks for a considerable time but as often as not separating from the flocks and feeding alone or in pairs. As Butts (1931) pointed out, this species is likely to have its own customary feeding range independent of that of chickadees.

5. Golden-crowned Kinglet:—While this species was frequently observed with chickadees it usually formed its own small flocks which moved independently. On October 28, November 3, and November 6, Golden-crowned Kinglet flocks were followed instead of chickadee flocks. Several times during these observations chickadee and kinglet flocks met, intermingled for a short time, and then continued in different directions, neither flock having any effect on the movement of the other. Kinglets, like chickadees, were continually vocal and had their own contact, 'lost,' and warning notes. Like the Red-breasted Nuthatch, kinglets are also partial to conifers, and where evergreens were available the flock remained in this habitat. This species also moved at a considerably slower rate than chickadees, and the flock tended to be more compact.

6. Brown Creeper:—The status of this species was hard to determine since it was difficult to follow in the woods and was never very common. In general, however, creepers were prone to follow Golden-crowned Kinglet flocks rather than chickadee flocks. Thus, in the above observations, creepers were continually present with the kinglets and did not separate to follow chickadees when the latter passed by. This is perhaps only to be expected since the creeper's notes are very similar to those of the kinglet.

7. Woodpeckers:—Downy and Hairy Woodpeckers as well as other species were the least sociable of the small forest species; individuals generally moved about independently and rarely remained with a chickadee flock for any length of time. Transient Flickers were somewhat gregarious but entirely independent of chickadees,

while transient Yellow-bellied Sapsuckers were slightly more sociable.

8. Juncos, Tree Sparrows, and other fringillids:—Flocks of these species often fed in the same vicinity (forest edge, for example) with chickadees but were entirely independent in their movements. Here association seems to be largely if not entirely a matter of overlapping habitat choice.

Feeding and other activities.—Feeding is the principal diurnal activity of individuals in the autumn and winter flock. Other activities include: resting, preening, drinking, bathing, avoidance or scolding of enemies, general vocalization, dominance reactions, and movements from one place to another. In cold weather nearly all energy is spent in seeking food; in warm weather a proportionally larger time is devoted to other activities.

According to Forbush (1929) the food of the chickadee as shown by stomach analysis at various seasons is 68% animal (mostly small insects) and 32% vegetable (including seeds and fruit). Although no stomachs were examined during this study, a few field observations may be of interest. Chickadees are very versatile in seeking food, foraging from the ground to the tops of trees in a variety of habitats, although generally feeding at low or intermediate levels in trees and shrubs. Van Deventer (1936) found that winter chickadees were more often observed between 0 and 10 feet than at any other 10-foot horizontal level. Considering the year as a whole, five main types or methods of feeding were observed as follows:

1. Foliage examination:—Much of the insect food during the open season (spring, summer, and autumn) was obtained from both broad-leaved and coniferous foliage, and apparently some food was obtained from the latter in winter. Birds were especially fond of examining and tearing open bunches of dead leaves, cocoons, or the hiding-places of leaf-folding and leaf-rolling larvae; frequently, birds could be located by the crunching sound accompanying this activity. Large, soft-bodied green caterpillars of unidentified species were favorites during the nesting season and were frequently brought to the young. The forest tent caterpillar (*Malacosoma disstria*), periodically abundant in the region, was avoided. However, birds were several times observed to eat large woolly caterpillars (probably *Isia isabella*); the soft insides were deftly removed and the hairy outer covering was discarded. In the spring, individuals spent much time examining the opening buds and catkins of deciduous trees, especially aspen and willow; as nearly as could be determined animal rather than vegetable food was being sought.

2. Twig and bark examination:—Observed at all times of year, but most often in winter. In this type of feeding the 'acrobatic' ability of the chickadee comes into play. In addition to gleaning small insects from in and under bark of twigs, limbs, and trunks, birds were adept at locating and catching tree-trunk moths despite the latter's protective coloration.

3. Seeds and fruits:—Hemlocks (*Tsuga canadensis*) bore a large seed crop in 1939-40 and hemlock seeds were a large item in the autumnal and winter diet, perhaps more than average. In several observation periods the flock spent as much as half the time feeding on this item alone. Seeds were removed directly from the cone as birds hung upside down or sometimes the entire cone was removed and held by the feet. Birds also spent much time and energy storing seeds in cracks and crevices during the fall. Storing activity was first noted on October 12 and continued into November. On October 25, one bird made sixteen trips in six minutes between a hemlock and a yellow birch, storing seeds in the loose bark of the latter. After December no storing was observed under natural feeding conditions although birds continued to feed on hemlock seeds. I was not able to determine whether birds later returned to their caches.

Other fruits of trees and shrubs which were eaten include the following: staghorn sumac (*Rhus typhina*), yew (*Taxus canadensis*), thorn apple (*Crataegus* sp.), black alder (*Ilex verticillata*), and bird cherry (*Prunus pennsylvanica*).

4. 'Weed' top examination:—This type was restricted largely to October and November when birds invaded fields and field borders. It was rather surprising to observe chickadees clinging to the tops of goldenrods (*Solidago juncea* and *S. graminifolia*), asters, and other Compositae much in the manner of small finches. Birds not only fed on the seeds of these herbs but also skillfully picked open the stems and removed insect larvae from within. During several observation periods birds spent as much as a third of the time feeding in this way (as in the case of the all-day observation of October 26).

5. Ground feeding:—Not a small part of the chickadee's food was obtained from or near the ground although birds seldom remained on the ground very long at a time. Generally, they flew down to the ground momentarily to pick up a seed or insect, returning to a low limb to eat it. In winter, birds were often observed hopping on the surface of the snow, picking up hemlock or other seeds which had fallen from trees above.

Chickadees bathed and drank frequently in the numerous small

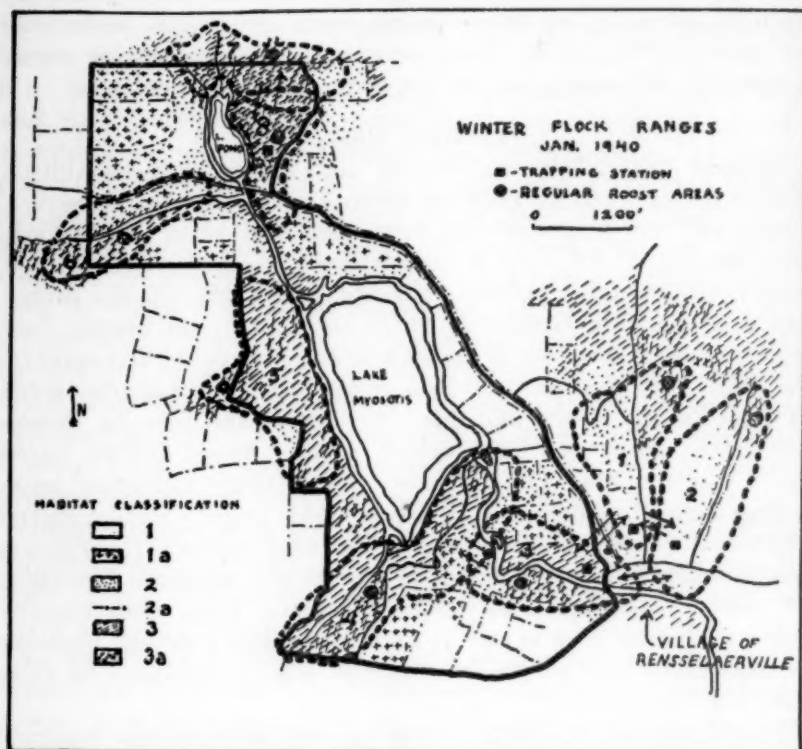
streams of the area during the autumn. Imitation was noticeable here since usually not one but several birds in the flock would fly down to drink or bathe. In winter, when everything was frozen over, what appeared to be 'snow bathing' was observed. Birds would fly down to where the sun shone on the snow and wriggle around on the moist surface. Also, birds were twice observed eating snow, presumably obtaining water in this way.

ROOSTING HABITS

Autumn and winter.—In autumn and winter most individuals roosted in dense conifer branches rather than in cavities. However, during the winter two cavities were discovered where single birds spent the night. One was a natural cavity about ten feet up in a small beech, the other an old woodpecker hole in the top of a twenty foot dead ash. On January 29, at the beech cavity the roosting bird was observed to drop out of a flock and enter the cavity very quickly; the other birds continued on to a group of hemlocks nearby, going to roost in the upper branches. Neither of the roosting cavities was subsequently used as a nesting cavity. Mogall (1939) found that Great and Blue Tits commonly roosted singly in nesting boxes during winter in Germany. Williams (1941) found Chestnut-backed Chickadees (*Penthestes rufescens*) roosting singly under eaves of houses and in vines, and quotes Bassett as reporting a Mountain Chickadee (*P. gambeli*) roosting in an old Robin's nest. Thus, while roosting habits of Paridae seem to vary in different regions, a definite tendency to roost singly and to select a sheltered place is indicated by these scattered observations.

Despite this individualism in roosting, there was a definite tendency for chickadee flocks on the Huyck Preserve to roost in the same section of woods or group of trees each night, especially in winter. Therefore, it was possible to station oneself at a known roosting area and observe the birds coming to roost. Commonly, the flock would feed up to a few minutes before roosting time; then individuals would give the flight note and start towards the roosting place. As a result, the flock was often strung out so that the birds arrived at the roosting area a few at a time, and each quickly sought out a place in densest foliage, especially out near ends of limbs. Usually only the contact and flight notes were given, sometimes a few songs. Within ten minutes or less after the first birds arrive all birds may be settled for the night sometimes at widely scattered points in the area. Calling stops as soon as the birds stop moving about which makes it very difficult to locate the exact roosting spot of individuals.

In the morning, loud chickadee calls are given which act as a general signal for individuals to leave their scattered roosting places and re-form into a flock.



TEXT-FIGURE 3.—Winter feeding ranges of flocks in January, 1940 (compare with Text-figure 1—Auk, 58: 316, July, 1941). The boundary of the Edmund Niles Huyck Preserve is indicated by the heavy solid line, the Village of Rensselaerville lying to the east. Heavy dotted lines mark the boundaries within which a group of birds was generally restricted. Arrows indicate known cases where birds passed from one flock to another. The habitat classification is as follows: (1) abandoned fields, herb and shrub stage; (1a) abandoned fields, artificially planted in conifers 10–13 years ago; (2) young forests or “second growths”; (2a) hedgerows; (3) mature, primarily deciduous forests; (3a) mature, primarily coniferous forests (hemlock, hemlock-beech, hemlock-white pine, hemlock-birch, etc.).

During the autumn, birds frequently roosted in low conifers, such as the pine plantations on the Preserve (Text-figure 3). While it was rarely possible to observe individual birds actually select a roosting spot, so quickly and completely did they hide them-

selves, it was possible to dislodge the birds from the low branches after dark, proving that they were roosting there. Five such low roosting places were located during October and November, three of which were known to be used on successive nights. During the winter, however, these low places were abandoned and birds roosted mostly in tall hemlocks, pines, or spruces (planted). The location of the regular roosting places used by winter flocks is shown in Text-figure 3.

Location of roosting areas seems to have possibilities as a method of censusing, especially during the winter fixation period. At least estimates by this method checked well with estimates based on banding and location of flocks in the daytime.

Breeding season.—As the flocks break up and pairs separate out or form in the spring, the winter roosting places were abandoned. During the pre-nesting movements the pair seemed to roost wherever it was convenient. The sexes were not observed to roost close together like Wren-tits (Erickson, 1938); in two out of three observations they did not even roost in the same tree, as may be seen by the following observation:

April 15. Pair no. 5. 5:49 p. m. Male flew up from a low bush where he had been feeding, called *chickadee*, flew across an opening into the top of a thirty-foot hemlock located in the middle of an isolated clump of trees. With aid of field glasses able to see bird perched on a small twig and nearly hidden by dense foliage. Here the male remained motionless as night came on but did not immediately assume characteristic roosting pose (head buried in scapular feathers). In the meantime (5:51 p. m.) the female had disappeared. Going over to where she was last seen I flushed her from a low branch of another hemlock. After scolding she worked out along another limb and roosted near the end about eight feet up. Returning later with a flashlight I was able to locate her in same place. Thus, members of the pair roosted 150 feet apart in different hemlocks.

As previously described (part 2) the female roosted in the nesting cavity from the time it was completed until the young were well developed. The male always roosted elsewhere; in one case he roosted in a small maple near the cavity on two successive nights and could be observed with a flashlight. After the young left the nest the family roosted wherever they happened to be. Likewise roosting places in late summer seemed to be more or less temporary although only a few observations were made.

Time of roosting.—The roosting time of the flock was recorded as the time when the last call was heard; by that time all birds were usually settled in roosting places. Observations of roosting time of flocks in relation to sunset (data obtained from the 'World

Almanac,' with corrections for Rensselaerville latitude) are summarized below. Plus figures indicate number of minutes before sunset; minus figures, minutes after sunset:

	October	December	January	February	March
Total observations:	6	2	14	4	3
Average	-7 min.	+3 min.	+23 min.	+20 min.	+35 min.
Variation	+1 to -12	+9 to -4	+40 to +5	+29 to +15	+48 to +25
Clear days:					
No. observations	3	1	6	3	0
Average	-10	+9	+20	+18	-
Partly cloudy days:					
No. observations	0	1	3	1	2
Average	-	-4	+19	+23	+28
Very cloudy or snowing:					
No. observations	2	0	4	0	1
Average	-1	-	+26	-	+48

A few observations on the time of roosting of pairs or single birds during the nesting season may be summarized as follows:

	Female	Male	Remarks
April 16	+50 min.	+49 min.	Pair 5, both in evergreens
April 27	+27	+27	Pair 1, both in evergreens
*May 13	+71	+62	Pair 1, before egg laying
*June 4	+29	+16	Pair 3, egg-laying period
*June 5	+43	+17	Pair 3, egg-laying period
*Aug. 3	+17	?	Pair 16, feeding young
*Aug. 5	+17	?	Pair 16, feeding young
*Aug. 8	+16	+8	Pair 16, feeding young
*Aug. 9	-1	?	Pair 16, feeding young

*Female roosting in cavity, male roosting elsewhere.

Despite the small number and considerable variability of these two sets of observations several interesting things are indicated (which, however, need to be checked by further observations): (1) Roosting time varied with the season; flocks roosted later in relation to sunset during October than during the winter months, and apparently individuals tended to roost earlier in April and May than in the summer. (2) Birds roosted earlier on cloudy and especially snowy days than on clear ones. (3) With the beginning of cavity roosting during nesting the female of the pair retired first, the male sometimes continuing to feed for some time after the female had entered the cavity for the night.

Seasonal variation in roosting time in relation to sunset has been indicated for the European Tree Creeper (*Certhia familiaris britannica*) (Rankin and Rankin, 1940), Chestnut-backed Chickadee

and Bewick's Wren (*Thryomanes bewicki*) (Williams, 1941). Nice (1939) found that the awakening song of the Song Sparrow was influenced by the time of year since it varied somewhat from the sunrise curve, tending to follow more closely the curve for civil twilight. The Tree Creeper roosted earlier (in relation to sunset) in spring than in December and January, similar to the trend in the above data. Williams (1941) found a similar sex difference in roosting of the Chestnut-backed Chickadee, the female roosting earlier and arising later than the male. Williams also found some evidence to show that weather affects roosting time independently of light intensity since birds roosted at relatively high light intensities on rainy days. Allard (1937) comments that many species seem to begin singing or other activity promptly at certain times in morning but do not seem to end singing or other activity with quite the same regularity.

A few observations were made on the time of leaving roosts in the morning. Two observations in October averaged two minutes before sunrise and three observations in January averaged six minutes before sunrise. Compared to many other small birds, chickadees are early to roost and late to arise. In winter, Tree Sparrows were regularly active and feeding one-half to three-quarters of an hour after chickadees had roosted. Likewise, Tree Sparrows and Pine Grosbeaks were observed coming from roosts a half-hour or more before chickadees in the morning. In the summer, such birds as thrushes and Song and Field Sparrows sang long after chickadees had roosted and become silent. Thus, in October chickadees spent about 13 hours on the roost, and in January between 14 and 15 hours. This long period is of special physiological interest since it means that the birds must be able to tolerate a long period without food at the low temperature of the winter season. Williams (1941) found that Chestnut-backed Chickadees spent more time on the roost than Bewick Wrens (from thirty minutes to one hour and fifteen minutes longer); the chickadees consistently roosted before sunset, the wrens after sunset.

Roosting chickadees have been observed closely both in captivity and in the field. In all cases the head was turned back over the shoulder and the bill buried in the feathers of the scapular region. Except at high temperatures (under experimental conditions) the feathers were fluffed out so that the roosting bird resembled a fluffy ball with a black stripe across one end and a tail protruding from the other.

DOMINANCE RELATIONS

The 'peck-order' or social organization of bird flocks has been intensively studied in flocks of domestic or caged birds (see Allee, 1936) but little study has been made with wild flocks. The dominance relations within one of the village flocks were studied in detail during the winter and early spring, and occasional observations made on other flocks. About thirteen birds regularly visited the feeding station with others appearing from time to time, especially in the spring. When feeding away from the station the birds traveled as a flock or as two or more flocks. Behavior of each individual in relation to every other individual was observed at the feeding station and also under natural feeding conditions where contacts were less frequent. Three criteria of dominance were used: (1) actual fighting, (2) bluffs, threats (with open bill), or use of the dominance note, (3) withdrawal of the bird at the approach of another (hence indicating subordination). The last criterion was applied only in clear-cut cases and was used mainly to supplement the other two criteria. About 600 dominance reactions between the color-banded individuals were recorded between January 15 and April 15.

There was a definite dominance order in the flock studied. Individual A-RG, male, was the top bird dominating all others. A-RY, male, was next, dominating all birds except A-RG during the winter, although this individual yielded the second place to A-GR, also male, in late February and March (see below). Likewise, A-Y, sex unknown, was clearly at the bottom of the winter group being displaced readily and frequently by every other bird. A-GY, sex unknown, dominated only A-Y, while A-BI, female, dominated only A-Y and A-GY. However, the dominance order was not entirely linear nor definitely fixed. Dominance was not clearly established between some of the intermediate birds, one individual being dominant one day or in one situation and the other being dominant another day or in another situation. There was some indication of a triangle relationship between three of the intermediate birds. Where dominance was clearly established, the subordinate bird usually withdrew without argument when the dominant bird approached, threatened with open bill, or gave the dominance note (often all three happened simultaneously). Since the subordinate bird was usually quick to get out of the way, no blow was actually passed in such cases. Actual fighting, therefore, took place mostly between closely ranked birds. On the other hand, contacts between certain closely ranked individuals were few, the two birds seemingly having a mutual respect for each

other and avoiding contacts. Displacements were most frequent between the top four or five birds and the bottom four or five.

In the group of thirteen birds there was a possibility of 78 different inter-individual contacts. Of the 78, 54 were (as far as observed) always in the same direction; that is, one bird was able to chase the other. In 18 cases the situation was one of give and take, with first one and then the other individual winning out. In six cases there were little or no data. Thus, this social hierarchy of chickadees resembled the 'peck right' system of the domestic fowl in the case of most individuals, and the 'peck dominance' type in the case of some of the intermediate or closely ranked birds. In other words the 'peck-order' seemed to be fairly rigid but not absolutely so.

On the whole, the dominance order changed very little during the winter and early spring. A-GR, mentioned above, was, however, a notable exception. In January, this individual was low ranking, avoided contacts and was even dominated by A-B1, female. During February, he became more aggressive, gradually improving his status until by March he was ranked as no. 2, chasing all birds except A-RG, the 'kingpin.'

Birds which visited the station occasionally from the two neighboring flocks were, without exception, relegated to a low position in the dominance order. One visitor, however, worked up to a high position after several visits. The three birds which joined the flock in March remained in a low position, being dominated by all but the lowest two or three birds. One of these spring arrivals proved to be a female and eventually mated with the no. 1 bird. A similar situation in regard to newcomers was observed when birds were experimentally transferred from one flock to another (Odum, 1941).

Dominance reactions were not restricted to feeding stations, although contacts were less frequently observed in loose flock formations under natural conditions. Displacement, chasing, use of 'dominance note,' and occasionally a fight were observed, similar to those on the feeding shelf. Chasing and fighting were especially vigorous among immatures in the late summer and autumn flocks. Here fighting was often clearly not over food, indicating that establishment of dominance is a fundamental social trait not necessarily associated with feeding. With the constantly changing population of autumn it is probable that dominance relations are continually being worked out and that a fixed system does not develop until the winter fixation period.

Mrs. Hamerstrom (1942) independently has made a study of

dominance in winter chickadees in Wisconsin, also finding that relations were generally unilateral. Her results, however, indicated an even more despotic type of social order than mine. This difference may be due to her smaller number of observations and the fact that she used only actual fighting as a criterion which, it seems to me, overlooks many interesting dominance reactions where an attack by one bird is not opposed by another resulting in a definite displacement but not in a fight. Of 76 fights observed by Mrs. Hamerstrom only one reversal was noted. According to Allee (1938) the only bird so far studied in his laboratory which has a fixed dominance order approaching that of the fowl is the White-throated Sparrow (*Zonotrichia albicollis*) recently reported on by Wessel and Leigh (1941). In flocks of three to five of this species the social order was a straight-line type; with larger flocks triangles developed. It is interesting to note that the White-throat, like the chickadee, flocks but loosely. Likewise, observations by Tompkins (1933) on several species of winter birds in California indicated that the most solitary species, a San Francisco Towhee (*Pipilo maculatus falcifer*), had the most rigid dominance relations. The social hierarchy of most birds which have been closely studied—i. e., canaries, pigeons, parakeets—is not fixed ('peck-dominance' type). These later species, theoretically at least, tend to flock more closely. This suggests that there may be important relations between the type of social order and the type of flock under natural conditions.

To sum up, dominance would seem to be important in at least four ways in wild-chickadee groups although much more study is needed. First, as indicated above, males were usually but not always dominant over females. In the case of pairs which formed from these and other flocks, the male was strongly dominant over the female while the two were in the flock. Hence dominance is probably involved in pairing. Secondly, as already indicated in an earlier part of this paper, the three top males were the ones that remained on or near the winter feeding range to establish territory and nest, indicating as Shoemaker (1939) has shown that social dominance and territory are related. Thirdly, dominance may play a role in winter survival. Certainly dominant birds had the advantage at the feeding station because low-ranking birds were forced to make more trips to the station since their feeding was often interrupted. However, whether this is of any importance under natural feeding conditions is a question (see Hamerstrom, 1942). Finally, as previously suggested, the type of dominance order may have something to do with the char-

acteristic loose organization of chickadee flocks. This is perhaps the most interesting and significant possibility and should be investigated further.

WINTER DISTRIBUTION

The winter feeding ranges¹ of the eight more or less well-defined flocks as of January 1940, are shown in Text-figure 3. The locations of regular trapping-stations and flock-roosting areas are also shown. The map is drawn to the same scale as Text-figure 1 (see part one). The area within which a group of birds were regularly restricted is indicated by the heavy broken lines. Several ranges overlapped to an appreciable extent. As previously pointed out, winter flocks were not entirely stable; some individuals ranged farther than others or were inclined to pass from one group to another. Arrows indicate known cases where individuals passed from one flock to another. Nevertheless, flocks were often remarkably restricted in their movements and constant in individual composition, as Wallace (1941) found at Lenox, Massachusetts. Thus, although feeding stations in flock ranges 1, 2, and 3 were only 200 to 300 yards apart, only four or five birds out of about forty visited more than one station since the flocks generally ranged in different directions. Experiments in winter homing previously reported (Odum, 1941) showed that many individuals returned promptly to winter areas when removed short distances (birds were transferred from ranges 1 and 2 to range 8) while others did not return and a few even remained at the point of release.

The size of these winter areas as drawn in Text-figure 3 varies from 21.8 acres to 55.8 acres, averaging 36.1 acres (approximately 14.6 hectares). Butts (1931) estimated one winter range to be about 40 acres. The number of birds using these areas varied from twelve to fifteen in the village and in ranges 6, 7, or 8 to but five or six in ranges nos. 4 and 5. Birds were, therefore, concentrated in the village and in the extensive hemlock and beech-hemlock stands around Lincoln Pond.

Consideration of the winter fixation period brings us to the end of one complete year since the paper started with spring movements and pair-formation. Of the total banded population present in late February, 18% remained on or near the winter feeding range to nest, 29% moved to other parts of the study area, and 53% disappeared, apparently moving out of the study area.

¹ "Winter territory" is used by some authors but since the winter areas are not defended, "feeding range" is preferable.

RESUMÉ OF THE ANNUAL CYCLE

Considering the annual cycle as a whole, the behavior of the chickadees resolves itself into six major seasonal patterns. These correspond well with the six seasons—prevernal, vernal, estival, serotinal, autumnal, and hiemal—which animal ecologists have proposed for the classification of aspection phenomena in temperate climates. Therefore, while I am aware of the shortcomings of any attempt to pigeonhole what in Nature are continuous or overlapping events, it may be instructive to review very briefly the chickadee's year in six parts as follows:

1. *Prevernal period* (March).—Spring movements, characterized by increasing restlessness and singing, shifting of birds from one flock to another, appearance of new birds and disappearance of others. In 1940, this period was delayed and prolonged into April by unseasonable weather.

2. *Vernal period* (April).—Preliminaries to actual reproduction including gradual breaking up of flocks and dispersal of individuals or pairs, pair-formation apparently resulting from simplified courtship, beginning of territory establishment following rather than preceding pair-formation.

3. *Estival period* (May–June).—Period of actual nesting in which most individuals are paired, remain in and defend territories. The sexes cooperate closely in all the nesting activities although only the female carries in nesting material and incubates. The male aids in cavity excavation, feeds the female during egg laying and incubation and takes an equal or greater share in feeding the young. The incubation period is about 13 days, the young remain in nest 16–17 days and remain a month or less with parents after leaving. This period was prolonged by a second brood or second nesting attempts in the case of some pairs.

4. *Serotinal period* (July–August).—Characterized by movement and flocking of juveniles and the molting of adults. The flocking habits reappear and the woods become 'alive' with noisy roving flocks. The family group does not form the basis of the flocks since juveniles scatter widely while adults remain for the time being on or near former nesting territories.

5. *Autumnal period* (September–November).—Characterized by autumnal movements, high population, mixed flocks, and general high sociability. Juveniles apparently may move long distances, adults short distances, but more data are needed. Transient warblers, vireos, and Ruby-crowned Kinglets consistently flock with chickadees; other

species are less strongly associated. This is probably the most 'care-free' period in the chickadee's year since nesting and molting are over and temperatures have not yet become low enough to make the business of living critical. On the other hand, judging from the frequency of observed attacks, the danger from accipitrine hawks is probably greatest at this time.

6. *Hiemal period* (December-February).—Winter fixation period, when most individuals remain within restricted areas of 20 to 50 or more acres and associate in small flocks. Apparently, well-defined dominance orders may develop in winter flocks. Feeding is the most important activity, and concentrated food, whether natural or artificial, may influence habits and distribution. Despite the rigors of the winter climate the study area maintained more birds at this season than during the estival period.

SUMMARY

(Part 1)

1. A study of the Black-capped Chickadee (*Penthestes atricapillus atricapillus*) during one complete year was made on the Edmund Niles Huyck Preserve, Rensselaerville, New York, and adjoining areas during 1939-40. The present paper summarizes results of the field study.

2. Colored bands in addition to numbered ones were used to permit exact individual recognition in the field. Birds were banded during the winter and spring at feeding stations; other adults and nestlings were banded at the nests, all of which were located in natural situations.

3. All observations were made within a two-mile diameter with the most intensive study carried on within the 476-acre Preserve and 100 acres of the adjoining village of Rensselaerville. The study area is located on the Helderberg peneplain at an elevation of 1400 to 1700 feet, ecologically lying in the ecotone between northern coniferous and eastern deciduous forest biomes. A wide variety of habitats ranging from abandoned fields to young beech-hemlock climax is present.

4. Chickadee population on the study areas experienced considerable seasonal variation. A peak of approximately thirty birds per 100 acres was reached on the Preserve in the fall, while a similar peak was reached in the village during the winter. Population was greater in winter than during the nesting season in both areas, the ratio being 15 to 6 on the Preserve and 30 to 4 in the village vicinity.

5. Unlike the way with many passerines, courtship and mating take place before the establishment of a definite nesting territory which may or may not be established at the place where pairing occurred.

6. Little evidence was found for the existence of definite pairs in the winter flocks, although pairs remained together after nesting. Published banding evidence indicates that chickadees (and many other Paridae) may retain the same mates in successive seasons, mortality permitting, but apparently the bond (if any) between the pair is ill-defined during the winter flocking period.

7. The break-up of winter flocks was gradual with pairs or single birds separating out a few at a time. Not more than two pairs remained to nest on any one winter range and one range was evacuated completely. Some birds were followed or later located within a mile of winter areas but many (about 53%) disappeared, apparently moving a greater distance.

8. No clear-cut courtship ritual was observed; courtship is apparently simple, although perhaps prolonged, involving use of loud *phoebe* songs by the male, a special twittering mating note, and wing-fluttering ceremonies.

9. Begging by the female and feeding of the female by the male are apparently not a part of courtship in chickadees since this behavior was not observed until later, particularly during incubation.

10. Behavior of birds which lost mates was described. A new mate is readily accepted when one is lost. One female had three mates during the nesting season. No cases of polygamy were encountered.

11. Establishment and defense of a definite nesting territory begins about the time of cavity excavation and ends when the young leave the nest; the finding of a suitable nesting site is probably an important factor. The male assumes the leading rôle in territory defense which follows three steps: vocal challenging, chasing, and rarely actual fighting. Observations are interpreted as indicating that 'fighting' for the mate gradually changes to 'fighting' for territory.

12. Where there is contact with neighbors the territorial boundaries may be sharply marked out; otherwise boundaries are not rigidly fixed.

13. Territories at maximum size patrolled, varied from 8.4 to 17.1 acres, averaging 13.2 acres (5.3 hectares). The size of territory and the vigor of its defense decreased as nesting progressed.

14. Two distinct habitats, an early seral and a late seral vegetation stage, were often included in a territory correlated with requirements for nest site on one hand and feeding-resting places on the other.

(Part 2)

15. Both sexes working in close coördination excavate the nesting cavity, although the female apparently takes the lead; chips are carried a short distance away. The pair work intermittently throughout the

day spending the inattentive periods in other parts of the territory.

16. The depth of cavities varied from 5 to 6.25 inches and the inside diameter from 2.5 to 2.75 inches; entrances were variable. Well-decayed stubs of early successional trees were most often selected.

17. Hair of the cottontail (*Sylvilagus floridanus*) was conspicuous in all seven nests examined; other hair, plant down, thin bark and strings were also used.

18. The number of eggs varied from five to eight, with four out of seven sets having seven eggs. Eggs are laid one a day and covered with nesting material by the female; the female spends the night in the cavity before and during egg laying, but apparently does not begin incubating until the set nears completion.

19. Contrary to a few standard references, no evidence was found to indicate that the male incubates; only the female developed a brood-patch and incubated, although the male often came to the nest to feed the female.

20. The average attentive period of three females was 24 minutes, the average inattentive period, 7.8 minutes. The male announces his approach to the nest with a signal song. During the inattentive period the female begs constantly and is fed at intervals by the male; in the meantime she feeds herself. The incubation period was thirteen days in one case.

21. The behavior of adults during the first week after hatching is similar to that during incubation except that the male stops feeding the female and both feed the young. As the young increase in age the behavior of both sexes changes; brooding ceases, ceremonies are dispensed with, and both sexes behave very much alike.

22. The male fed two to four times more often than the female at first, but when brooding stopped, both sexes fed at about the same rate. Feeding advanced young places a great strain on the energy reserves of the adults so that survival time without food was found to be very low, less than 16 hours in two cases. Nestlings remain in the nest 16 to 17 days.

23. Morphological and physiological development of the nestlings is typical of altricial species. Weight increased from slightly over a gram at hatching to 9-10 grams at twelve days, with little or no increase during the remainder of nest life. Temperature control began to develop on the fourth day and by the twelfth nestlings were essentially warm-blooded. At average nest temperature (95° F.), the highest heart and breathing rates were recorded at nine days, believed to be the result of poor feather development at this age as compared with high development of the heat-production mechanism.

24. Fledglings were able to feed themselves ten days after leaving the nest and remained with their parents only three to four weeks. In late summer, adults tended to remain on or near their former territory but the juveniles scattered widely; hence, late summer flocks were not usually family groups.

25. Only one brood was attempted by most pairs although one female in 1940 and several in 1941 raised two broods.

25a. Of nests most closely watched 60% were successful, while approximately 70% of all eggs laid (including second layings) were fledged. Survival of the adults during the nesting season was 90%.

(Part 3)

26. Vocal activity is very important in regulating the behavior of chickadees, especially during the flocking period. Sixteen clearly distinguishable notes are listed, most of which have well-defined functions; eight function primarily in breeding behavior, and eight function primarily in general social relations.

27. The characteristic autumn and winter flocks are rather loose aggregations of individuals which do not move in a well-organized manner or have definite leaders. Chickadees are apparently strong individualists but at the same time have considerable social tendencies during the non-breeding season.

28. The number of individuals in natural flocks in the woods averaged seven to eight, while flocks or 'congregations' in the vicinity of village feeding stations were larger. The larger autumnal population on the Preserve resulted partly in larger flocks but mostly in more numerous flocks.

29. Flocks are not definitely fixed in size but may vary from day to day or even from hour to hour; flocks continually break up and re-form or individuals pass from one flock to another, especially in the autumn.

30. The average rate of movement of flocks was 1425 feet per hour. Movement, however, was not uniform but more or less rhythmic, periods of fairly rapid movement alternating with feeding periods in which there was little or no movement.

31. Flocks moved faster in the morning than in the middle of the day, faster on warm, cloudy days than on cold or windy days; the average rate of movement was greatest in October and greater in winter than in late summer.

33. Flocks usually did not move in any one direction for long but tended to double back and forth in an irregular manner over a fairly

definite area. No regular routes were followed, but favorite feeding places were sometimes visited repeatedly.

34. All-day observations seemed to indicate that rate of flock movement was proportional to area covered, which in turn was correlated with seasonal variation in habitat selection.

35. Arboreal warblers (particularly transients), vireos, and Ruby-crowned Kinglets consistently flocked with chickadees during late summer and autumn. Other species, such as White-breasted and Red-breasted Nuthatches, Golden-crowned Kinglets, Brown Creepers, and woodpeckers were often associated to varying degrees, but not generally on a true flocking basis.

36. Chickadees are very versatile in their feeding habits. Five main types or methods of feeding were noted as follows: (1) foliage examination (principally open seasons), (2) twig and bark examination (principally winter), (3) seeds and fruit (autumn and winter), (4) 'weed'-top examination (restricted to autumn), and (5) ground feeding (sparingly the year-round).

37. Most individuals roosted in dense conifer branches during autumn and winter, although two cavities were located where single birds roosted in winter. There was a definite tendency for flocks to roost in the same conifers on successive nights, especially in winter. In autumn, birds often roosted in low conifers, but in winter they roosted high up. While nesting, the female roosted in the nesting cavity, the male always roosted elsewhere.

38. Factors other than light intensity which apparently influence roosting time are season (birds roosted much earlier in relation to sunset in spring than in fall), weather as such, and sex (female went to roost earlier than male during nesting). Compared to many other species, chickadees are early to roost (consistently before sunset) and late to arise.

39. There was a well-defined dominance order in one of the winter flocks which was studied in detail. Dominance seemed to be well established and uni-directional between many individuals but the dominance order was not entirely linear or fixed. Males were mostly dominant over females, and newcomers or spring arrivals were relegated to a low position in the dominance order, at least at first. Under natural conditions the evidence indicates that dominance may be important in (1) mating, (2) territory, (3) winter survival (doubtful), and (4) in determining characteristic loose flock organization.

40. The winter feeding ranges of flocks were mapped on the same scale as nesting territories. Ranges varied from 21 to 55 acres, aver-

aging 36 acres (approximately 14.6 hectares). In winter, birds were concentrated in the village (where feeding stations are maintained each year) and in the extensive hemlock stands of the Preserve.

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OSSIFICATION IN THE NESTLING HOUSE WREN

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ISABELLE H. HELLWIG AND GERHARD DEUTSCHLANDER

As a necessary preliminary to work on the effects of certain hormones on the time relations of ossification and relative growth in the House Wren (*Troglodytes aëdon aëdon*), it was essential to determine this relationship in normal individuals. This paper in a qualitative manner discusses briefly the first appearance, fusion and articulation of bones in the skeletons of normal nestling House Wrens.

At least four birds for each day in the nest were collected. The birds were killed, the skeleton was stained with Alizarin Red S. and cleared by Dawson's method as given in A. B. Lee's 'The Microscopist's Vade Mecum' (Philadelphia, P. Blakeston's Sons and Co., 1937). There have been numerous articles published concerning this method but the authors have been unable to discover any extensive use of this technique for a study of this kind.

FORE LIMB

O day.—The humerus is a short thick bone with the ends slightly flared. The radius is about the same length as the ulna but thinner, not as heavily ossified, while the ends of the ulna are more flattened than those of the radius. The radiale and ulnare are not present. In the carpometacarpus the third metacarpal is heavier and larger than the fourth metacarpal; the latter is a slender bone while the ends of the third metacarpal are somewhat thickened. The second digit is a minute bone. In the third, both of the phalanges are present, although the distal is much smaller than the proximal. The fourth digit is not present, nor is the second metacarpal. [The three fingers of the hand are regarded as numbers 2, 3, and 4 of the primitive five.]

Third day.—Distal and proximal ends of the humerus are more expanded. The fourth digit and the second metacarpal have appeared.

Fourth day.—Present for the first time is the beginning of the tuberculum ulnare ossi metacarpi.

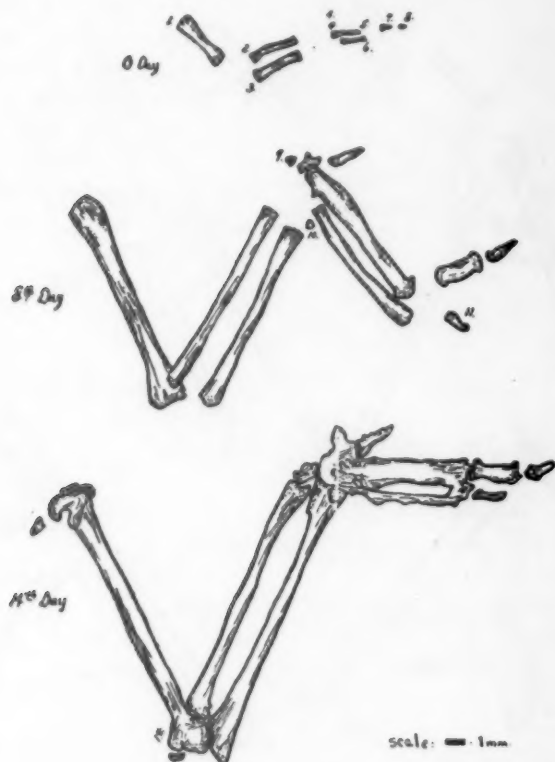
Fifth day.—The tuberosities of the humerus are much more prominent.

Seventh day.—The radial and ulnar bones are present for the first time.

Eighth day.—The tuberculum ulnare ossi metacarpi has united with the proximal end of the third metacarpal. Two small centers of ossification have appeared close to the third metacarpal, and a third

has appeared between the fourth metacarpal and the ulna. The epiphyses of the humerus and ulna have appeared.

Ninth day.—In the humerus the caput humeri is beginning to fit into the glenoid fossa. The fourth metacarpal has developed a slight indentation for articulation with the third metacarpal and the second metacarpal is touching the proximal end of the third metacarpal.

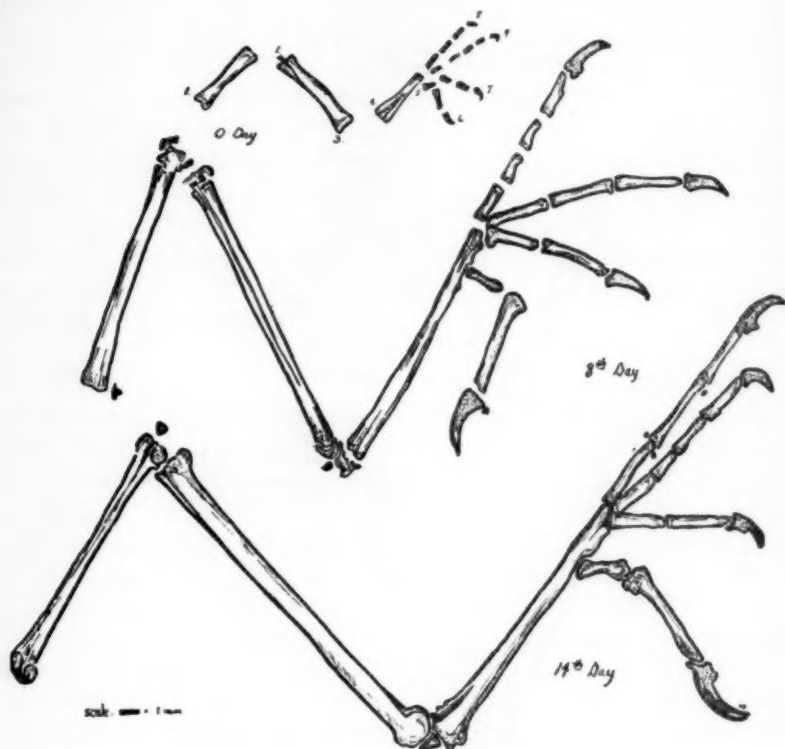


TEXT-FIGURE 1.—Fore limb of nestling House Wren: 1, humerus; 2, radius; 3, ulna; 4, second digit; 5, third metacarpal; 6, fourth metacarpal; 7, first phalanx of third digit; 8, second phalanx of third digit; 9, radiale; 10, ulnare; 11, fourth digit.

Tenth day.—The second metacarpal is beginning to fuse with the preaxial side of the proximal end of the third metacarpal.

Twelfth day.—The head of the humerus has now reached adult proportions. The trochleae are well formed on the humerus. The radius articulates with the humerus and radiale and the proximal end is expanded and concave for articulation with the oblique tubercle.

The proximal end of the ulna articulates with the ulna tubercle of the humerus while the distal end articulates with the radiale, ulnare and head of the third metacarpal. The third metacarpal has fused with the fourth metacarpal. The third finger articulates with the third metacarpal. Fusion of the epiphyses of the humerus is completed and the epiphysis at the distal end of the ulna is fused.

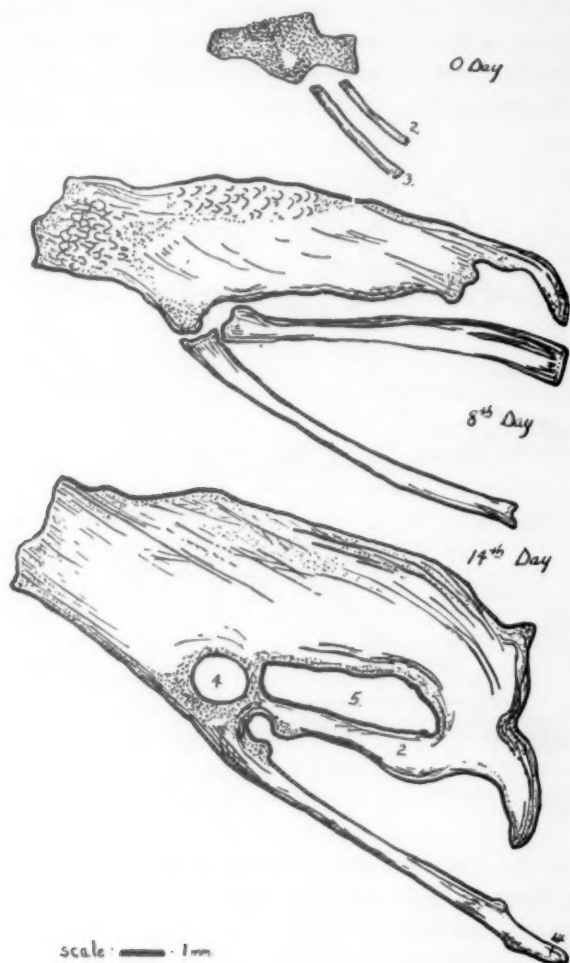


TEXT-FIGURE 2.—Hind limb of nestling House Wren: 1, femur; 2, fibula; 3, tibio-tarsus; 4, tarso-metatarsus; 5, remnant of first metatarsal; 6, first toe; 7, second toe; 8, third toe; 9, fourth toe.

Thirteenth day.—The radius articulates with the oblique tubercle and with the radiale at the distal end. The ulna articulates with the humerus. Two new centers of ossification have appeared at the distal end of the ulna. The radiale articulates with the radius while the ulnare is attached to the third metacarpal. The third metacarpal articulates with the second finger, fourth metacarpal, ulnare and

radiale. The *fourth* metacarpal articulates with the *fourth* finger.

Fourteenth day.—The radius articulates with the humerus and ulna. The radiale articulates with the radius and tuberculum ulnare ossi



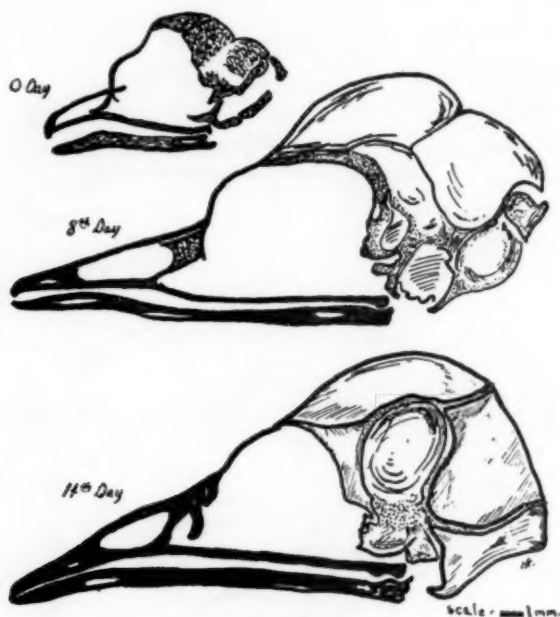
TEXT-FIGURE 3.—Pelvic girdle of nestling House Wren: 1, ilium; 2, pubis; 3, ischium; 4, acetabulum; 5, ilio-ischiac foramen.

metacarpi. The epiphysis at the proximal end of the ulna is fused, as are also the third and fourth metacarpals and the ulnare. The two centers appearing on the thirteenth day have now fused with the ulna. Also, the second metacarpal articulates with the second digit.

SHOULDER GIRDLE

0 day.—The scapula is a short stocky bone with the ends expanded. The coracoid is approximately of the same size as the scapula and has about the same amount of ossification. The clavicles are thread-like in thickness and are joined by the minute inner clavicle.

First day.—The coracoid bears hook-like processes on its upper end. These will be part of the glenoid fossa.



TEXT-FIGURE 4.—Skull of nestling House Wren; side view.

Third day.—Three tuberosities, which will articulate the anterior head of the coracoid with the other parts of the shoulder girdle and humerus, are now present.

Ninth day.—The furcula is almost touching the end of the scapula. A head is forming for articulation with the coracoid. A head is also forming on the furcula.

Twelfth day.—The distal portion of the coracoid articulates with the sternum and the proximal end articulates with the scapula to form the glenoid cavity.

Thirteenth day.—The scapula articulates with the humerus, coracoid and furcula.

HIND LIMB

O day.—The femur, tibio-tarsus, fibula, tarso-metatarsus, remnant of the first metatarsal, phalanges and claws are all present. The three bones that have fused to form the metatarsus are still visibly separated at both ends of the bone and only partially fused through the shaft. The first phalanx of the fourth toe is moderately ossified but the three other phalanges are barely distinguishable.

First day.—The proximal end of the femur has begun to develop into the caput femoris while the distal end shows the beginning of the condyle.

Second day.—A small center of ossification develops outside the distal end of the tibio-tarsus.

Fourth day.—Second small center of ossification develops outside the distal end of the tibio-tarsus.

Fifth day.—The metatarsus has an indentation on its inner posterior surface. A third center of ossification has developed at the distal end of the tibio-tarsus.

Seventh day.—The cap at the proximal end of the tarso-metatarsus is visible. The distal head of the tibio-tarsus is beginning to take form by the fusion of the three small bones mentioned above. A small sesamoid bone appears beside the proximal extremity of the tarso-metatarsus.

Eighth day.—Three centers of ossification have appeared at the distal end of the femur and mark the beginning of the patella. A small center of ossification has formed near the distal end of each of the three splints forming the tarso-metatarsus.

Ninth day.—The three centers of ossification that are close to the tarso-metatarsus fuse to form the triple trochlear head which articulates with the second, third and fourth toes. A center of ossification has developed at the anterior head of the fibula.

Tenth day.—The centers of ossification for the patella have fused. The center of ossification at the anterior head of the fibula has fused with the fibula, supplying a surface for articulation with the outer condyle of the femur.

Twelfth day.—A small center of ossification has developed by the cap at the distal end of the femur. The head of the femur now fits into the acetabulum. There are small ossified strands running from fibula to tibio-tarsus. The tibio-tarsus articulates with the anterior head of the tarso-metatarsus. The first metatarsal has joined the tarso-metatarsus. The third digit articulates with the metatarsus and the fourth partially so.

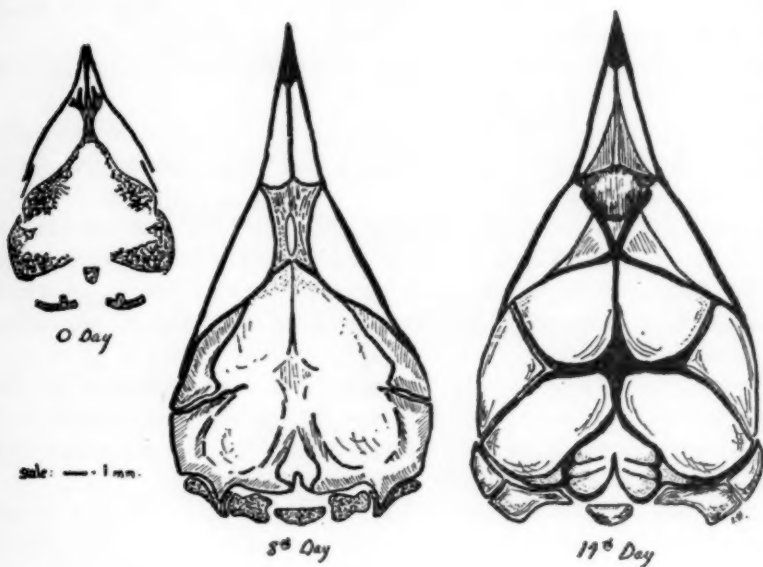
Thirteenth day.—Articulation between phalanges is now complete.

Fourteenth day.—Epiphysis of the femur, tibio-tarsus and tarso-metatarsus join their respective diaphyses.

PELVIC GIRDLE

0 day.—The three bones that constitute the pelvic girdle are present. The ischium is the most solidly ossified; beneath the ilium the lumbar vertebrae are easily seen, while the slender pubis is just distinguishable.

Second day.—The pubis is now clearly seen and is approaching the ilium.



TEXT-FIGURE 5.—Skull of nestling House Wren; dorsal view.

Third day.—The ends of the ischium are slightly expanded.

Fourth day.—The heads of the ischium are more expanded and a small head has formed on the anterior end of the pubis.

Sixth day.—Fusion is beginning between the ilium and the synsacrum.

Eighth day.—The three bones of the pelvic girdle have met to form the acetabulum, but the only fusion apparent is between the ilium and the ischium.

Tenth day.—The ilioischial foramen is just being formed with the fusion of the posterior ends of the ischium and the ilium.

Twelfth day.—The pubis and the ilium have fused at the acetabulum.

Thirteenth day.—The suture between the ilium and the synsacrum is evident and complete fusion of the pelvic bone is accomplished.

THE SKULL

O day.—The occipital shows four centers of ossification. The frontal and parietal are present but very lightly ossified. There are small processes on the temporal for later articulation with the quadrate. In the premaxilla, the lateral halves are completely fused together and the processi frontales are present. There are three main divisions of the maxilla and they are not yet completely fused. The nasal is very faintly ossified while the lacrimal is not present. The palatine appears to be joined to the nasal portion of the sphenoid. The pterygoid is connected with the palatine and the articular facet is beginning to develop. The zygoma is much curved with a slight widening of the posterior end (quadrato-jugal) while the jugal is already fused to the maxilla. The vomer is present but ossification is very slight. In the quadrate development has already progressed toward articulation with the temporal portion of the skull. The inferior maxilla can be seen very faintly. In the hyoid, two small bones are visible with their ends more heavily ossified. There are signs of ossification of the corneal margin of the sclerotic coat.

Second day.—Eye ring is complete but ossification is light.

Third day.—The four divisions of the occipital are still separate. The rostrum is present on the sphenoid. The temporal is joining with the frontal. The lacrimal still is not present. The pterygoid appears to be joined anteriorly to the posterior end of the palatine. The vomer is apparently fused with the rostrum of the sphenoid. In the hyoid a third center of ossification has appeared between the two previously mentioned. The plates of the eyes are much more distinct.

Fourth day.—The ear cavity is beginning to form in the temporal. The premaxilla has fused with the nasal. The pterygoid is fused with the rostrum of the sphenoid. The quadrate is about ready for articulation with quadrato-jugal. The os articulare of the inferior maxilla is beginning to form.

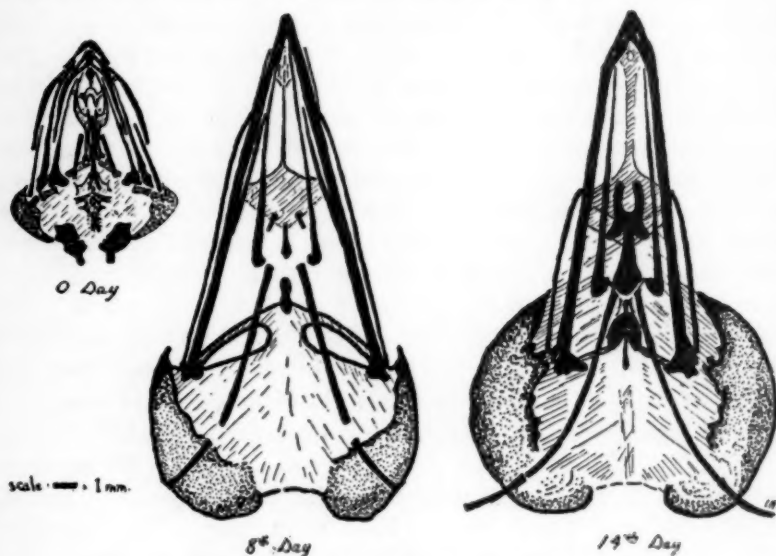
Fifth day.—The sphenoid appears to be connected with the quadrate and is nearly connected with the lateral occipital. The quadrate articulates with the os articulare of the inferior maxilla.

Sixth day.—There is fusion between the parietal and the lateral occipital.

Seventh day.—Pterygoid articulates with the quadrate while the quadrato-jugal is articulating closely with the quadrate.

Eighth day.—The lateral and supraoccipital parts have fused and the occipital is curving around to form part of the ear cavity. The sphenoid appears to be joining with or touching the occipital ventrally. The temporal and quadrate articulate. The palatine appears to be fused with the inner edges of pterygoid. The basi-hyal of the hyoid is present.

Ninth day.—The four parts of the occipital are all fused. Sutures between the two frontals extend down to the nasal bone.



TEXT-FIGURE 6.—Skull of nestling House Wren; ventral view.

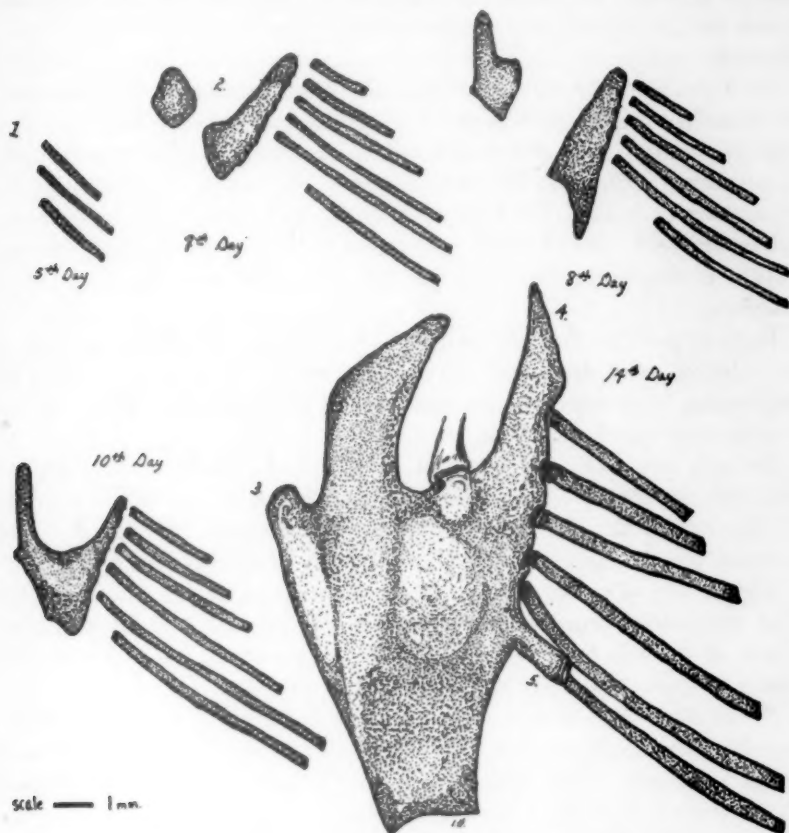
Tenth day.—There is general fusion between temporal, lateral occipital, sphenoid and quadrate. The lacrimal is seen for the first time. Zygoma and jugal articulate and the inferior maxilla articulates with the quadrate.

Twelfth day.—The temporal is fused with the sphenoid. By this time most of the skull bones are completely fused.

VERTEBRAL COLUMN, RIBS AND STERNUM

O day.—In the cervical region there are thirteen small vertebrae, each having three centers of ossification: the right and left halves of the neural arch and the centrum. The vertebrae do not yet articulate with each other. The atlas and axis are not as well formed as the other cervical vertebrae. The seven thoracic vertebrae are larger and

more heavily ossified but in extent of development are like the cervical. Eight ribs are present but unattached. The vertebral end of all but the first rib is slightly divided into the capitulum and tuberculum. In four of the specimens the first rib is difficult to see; in two others,



TEXT-FIGURE 7.—Sternum of nestling House Wren: 1, sternal ribs; 2, first ossification centers of body of the sternum; 3, keel or sternal crest; 4, costal process; 5, xiphisternal process.

it is well formed. No ossified sternum is present. The lumbar and sacral vertebrae are barely visible. In most of the specimens it was impossible to count the coccygeal vertebrae as ossification was not advanced enough.

Second day.—The pygostyle is present. It is not possible to distinguish all the coccygeal vertebrae.

Third day.—The processes of the thoracic vertebrae are developing and transverse processes on the last four sacral vertebrae are present.

Fourth day.—Processes of the cervical vertebrae are developing. The zygapophyses are beginning to develop as separate centers in the cervical region. In the thoracic region fusion of the centra with the transverse processes has taken place. The coccygeals are fused ventrally.

Fifth day.—In the cervical region the neural arch and the centrum are fused ventrally at each side. The atlas is not yet fused on the ventral side but is on the dorsal side. The last thoracic is beginning to unite with the first lumbar vertebra. A center of ossification is present on each side of the sternum and very light ossification is present in the keel. The lumbar and sacral vertebrae are fusing together. Fusion is beginning between the first coccygeal and the last sacral vertebra.

Sixth day.—The atlas is articulating with the axis and the axis is articulating with the next cervical vertebra. Five new centers of ossification have appeared on each side of the sternum. Many of the lumbar and sacral vertebrae are fused.

Seventh day.—The processes of the cervical vertebrae have united with the vertebrae. The atlas is articulating with the single condyle of the occipital. All the lumbo-sacral vertebrae are fused. The sternum has developed another large center of ossification in the keel.

Eighth day.—Fusion of some of the thoracic vertebrae has occurred. The transverse processes are touching the dorsal end of the ribs. Three of the ribs have developed uncinat processes. Another paired center of ossification has appeared in the sternum.

Ninth day.—The fusion of the thoracic vertebrae is still incomplete. Another rib has developed the uncinat process. In the lumbar and sacral vertebrae small processes are being formed dorsally. Fusion of the three bones that form the sternum is beginning.

Tenth day.—Fusion of the sternum is nearly complete.

Twelfth day.—The uncinat processes have joined the ribs and there is a general fusion of all vertebrae.

Thirteenth day.—In the dorsal region the superior processes are articulating with the small part of the rib articulars.

SUMMARY

Ossification of all the bones has begun in the newly hatched wrens with the exception of the second metacarpal, fourth digit, radiale, ulnare, eye ring, lacrimal, uncinat processes of the ribs, pygostyle and sternum.

Of these, the pygostyle and the plates of the corneal margin of the sclerotic tunic appear on the second day, the second metacarpal and the fourth digit on the third day, the radiale and ulnare on the seventh. Uncinate processes begin to develop on some of the ribs on the eighth day and the lacrimal begins on the tenth.

The first center of ossification for the sternum is present on the fifth day with new centers appearing successively until the ninth day, when fusion begins.

Ossification proceeds rapidly, with articulation and fusion almost complete by the time the nestlings are ready to fly.

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BODY TEMPERATURES OF ANTARCTIC BIRDS

BY CARL R. EKLUND

BODY-TEMPERATURE studies of Antarctic birds were conducted by the author while employed as ornithologist at the East Base, on the United States Antarctic Expedition, from November, 1939 to May, 1941.

The East Base was one of two bases established on the Antarctic Continent by the United States Antarctic Expedition, under the direction of Rear Admiral Richard E. Byrd. It was located on a small island, approximately 1,000 miles south of Cape Horn, in Marguerite Bay off the Bellinghausen Sea, adjacent to the west coast of the Palmer Peninsula, in Latitude $68^{\circ} 11' S.$, Longitude $67^{\circ} 12' W.$

Rather limited bird-temperature records from the Antarctic Continent have thus far been obtained, and this work was an attempt to add slightly to the present knowledge. During the study a total of 78 records covering observations on six species of Antarctic birds were made. All were taken within a fifteen-mile radius of the base. Birds included in the study were the Adélie Penguin (*Pygoscelis adeliae*), South-Polar Skua (*Catharacta skua maccormicki*), Kelp Gull or Southern Black-backed Gull (*Larus dominicanus*), Snow Petrel (*Pagodroma nivea*), Antarctic Tern (*Sterna vittata*), and the Giant Fulmar (*Macronectes giganteus*). Nesting records of the first four species were also obtained during the work.

Previous records on Antarctic birds have been made by Andersson, Clarke, Gain, and Vallette.

METHOD USED

A 4-inch Asepto rectal maximum-minimum thermometer was used, with recordings made to within a tenth of a degree. The thermometer was inserted at least three inches into the intestine, and was kept there three minutes. In each case the time of day was noted as well as the air temperature, if possible.

Whenever possible, recordings were taken on uninjured birds. All penguin, snow petrel, and most skua records were taken on birds not injured. Penguins were readily caught with a hand net on land, skuas were easily snared with a string, and Snow Petrels were captured after they had momentarily stunned themselves by flying against a building during the winter night. Temperatures were taken from wounded birds immediately after capture, and then only on specimens which were but slightly wounded. The one disadvantage of taking recordings from birds which were not wounded was that sex

was not determined, in many cases, because some of these birds were afterward released.

The following table gives the family, species, number of records, and maximum, minimum, and mean temperatures. All were rectal recordings:

TABLE 1
SUMMARY OF BODY TEMPERATURE RECORDS

Family and Species	Temperatures (F)			Number of records
	Maximum	Minimum	Mean	
Spheniscidae <i>Pygoscelis adeliae</i>	106.4 (juv.) 105.3 (ad.)	100.3	103.8	23
Laridae <i>Larus dominicanus</i>	107.4	104.2	105.77	16
<i>Sterna vittata</i>	106.2	105.2	105.63	3
Stercorariidae <i>Catharacta skua maccormicki</i>	108.4	103.4	106.14	30
Procellariidae <i>Pagodroma nivea</i>	104.1	102.1	103.3	3
<i>Macronectes giganteus</i>	105.8	104.3	105.03	3
			Total	78

Previous Adélie Penguin records taken by Andersson, ornithologist of Nordenskjöld's Swedish Expedition, near the Antarctic Circle at the northern tip of the Palmer Peninsula, found temperatures ranging from 100.2° F. to 104.9° F. Clarke, biologist for the "Scotia" Antarctic Expedition, found temperatures of this same species as high as 106° F. Vallette, an Argentine meteorological observer in the South Orkney Islands, recorded a South-Polar Skua temperature at 105.9° F., a Kelp Gull at 105.2° F., a Snow Petrel at 99.8° F., and a Giant Fulmar at 104.5° F. This same observer recorded an Antarctic Tern temperature of 107.9° F., while Gain, biologist on Dr. Charcot's French Antarctic Expedition, found a temperature for this same species of 102.9° F.

DIURNAL RISE AND FALL

Detailed investigations of the diurnal rise and fall of bird temperatures have been carried out by Wetmore, and Simpson and Galbraith.

Diurnal species, which are normally active during daylight hours, showed a constant rhythm indicated by a gradual temperature rise toward the latter part of the afternoon, and a corresponding decrease toward early morning. Nocturnal species showed a reverse temperature curve with the high reading late at night and the low during the day. Increased temperatures were definitely correlated with activity.

Peculiarities of Antarctic Continent weather present factors which are not normal to temperate zones. In addition to extreme, cold temperatures and a reverse in seasons of that of the northern hemisphere, there is a period during the summer in which there is continual daylight, and sight of the sun is never lost. Consequently an experiment was carried on, under these natural conditions, which might throw still further light on diurnal rhythm.

TABLE 2
HOURLY TEMPERATURE RECORDS OF *Catharacta skua maccormicki*

<i>Time of Day</i>	<i>Air Temperature</i>	<i>Body Temperature No. 1 Specimen</i>	<i>Body Temperature No. 2 Specimen</i>
3 P. M.	+33° F.	107.1° F.	107.9° F.
4 P. M.	+33	106.6	108.4
5 P. M.	+33	107.6	107.5
6 P. M.	+32	104.9	106.9
7 P. M.	+32	104.3	106.0
8 P. M.	+32	104.5	104.6
9 P. M.	+32	104.0	103.8
10 P. M.	+32	103.8	104.0
11 P. M.	+32	103.9	103.5
12 Midnight	+32	104.0	104.0
1 A. M.	+32	104.4	104.0
2 A. M.	+32	104.1	104.1
3 A. M.	+32	104.0	104.3
4 A. M.	+32	104.5	104.4
5 A. M.	+32	104.3	104.4
6 A. M.	+32	104.3	104.7
7 A. M.	+33	104.2	104.4
8 A. M.	+33	104.3	104.8
9 A. M.	+33	104.7	105.5
10 A. M.	+33	103.9	105.5
11 A. M.	+34	104.4	106.0
12 Noon	+34	104.9	105.5
1 P. M.	+34	105.4	105.7
2 P. M.	+34	105.2	105.5
3 P. M.	+34	105.7	105.2

Mean Average 104.76° F. 105.12° F.

During a period of continual daylight, in March, two adult South-Polar Skuas, the most southerly bird in the world according to present records, were taken alive. At these times this bird is more or less active for 24-hour periods, and they could always be observed eating and fighting among themselves over seal-meat scraps near the husky sledge-dog kennels. Simultaneous hourly temperature recordings were taken on both captured skuas for a period of 25 hours. One bird showed a high reading of 107.1° F. and a low of 103.8° F., or an average of 104.76° F., while the second had a high of 108.4° F. and a low of 103.5° F., or a mean of 105.12° F. Highest temperatures were reached around 3 P. M. after which there was a gradual decline to midnight. For the next three or four hours the temperatures remained somewhat constant, after which there was a gradual rise up to the middle of the afternoon.

Hourly air temperatures were also kept, but when compared to the bird temperatures no correlation could be found. Light westerly winds, with a foggy and overcast sky caused temperatures to remain steady, and the highest recording within this 25-hour period was + 34° F., with the lowest at + 32° F.

TEMPERATURE DIFFERENCE OF SEXES

Correlations on temperature differences between sexes were not worked out in detail, because many birds were released after recordings were taken, and sex was undetermined due to plumage similarity.

Most temperature work on this phase seems to indicate that the female has the higher temperature, although there are exceptions to this, especially in cases where the male helps with nesting and is otherwise more active than the female. In this work only recordings of the South-polar Skua and the Kelp Gull were of sufficient number even to indicate any differences. These recordings were made at the end of the nesting season.

TABLE 3
TEMPERATURE DIFFERENCE BETWEEN SEXES

Species	Number of Records		Mean Temperature	
	Male	Female	Male	Female
<i>Catharacta skua maccormicki</i>	4	9	106.1	106.5° F.
<i>Larus dominicanus</i>	4	4	105.5	105.8

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NUMBER OF EGGS LAID BY HERRING GULLS

BY DAVID E. DAVIS

INTRODUCTION

BIRDS in general lay a more or less definite number of eggs in each clutch. Many passerines, for example, lay between three and five eggs, usually four. The variations which occur are frequently due to differences in age, metabolism, weather, or number of previous clutches. In spite of these factors, the size of a clutch in any given species varies within narrow limits. In some birds the number of eggs in the nest determines the cessation of laying. In others laying stops after a certain number has been laid no matter how many may be in the nest.

In this paper are reported the results of experiments on the Herring Gull, *Larus argentatus*. Eggs were added to or removed from the nests to find out the effect on the number of eggs laid. The effects of age, metabolism or other factors on the ability of birds to produce eggs will not be considered here. Before discussing the experimental data it is desirable to outline briefly the generally accepted hypothesis of the neuro-endocrine basis of the problem (cf. Witschi, 1935; Laven, 1940) and mention relevant data.

Certain birds will continue to lay when eggs are removed from the nest. The Flicker, *Colaptes auratus*, for example (Phillips, 1887), in one case laid 71 eggs when an egg was taken daily from the nest. Presumably such species will continue to lay until the nest contains a definite number of eggs. These species may be called indeterminate egg layers. An external stimulus, probably either optical or tactile, apparently acts through the hypophysis to stop the production of eggs by the ovary. Birds that nest in dark holes probably respond to a tactile stimulus on the breast. Incidental experiments have indicated that several species are indeterminate egg layers but as yet no comprehensive series of tests has conclusively proved that any species will lay until the nest contains a certain number of eggs.

In contrast to the indeterminate type are those birds that lay a definite number of eggs no matter how many eggs are in the nest. These species may be called determinate egg layers. The hypophyseal-ovarian mechanism is apparently fixed to produce and ovulate a definite number of eggs even though eggs are added to or removed from the nest. The addition of eggs does not restrain the female from laying; the removal of eggs does not induce the female to con-

tinue laying. Probably most species are determinate, but adequate evidence is largely lacking.

The problem under consideration is one example of the interrelationships between the nervous and the endocrine systems. It is clear that in indeterminate egg layers a nervous stimulus (visual or tactile) is transformed, probably at the hypophysis, into an endocrine stimulus. Determinate layers do not respond to such external stimuli. A consideration of the probable function of courtship as a stimulation of ovulation suggests the notion that spontaneous ovulators are determinate egg layers and that non-spontaneous ovulators are indeterminate layers.

For the present it is sufficient to outline briefly the problems and indicate the scope of future work. Experiments incidental to other research have indicated the type of egg layer in several species (Watson, 1909; Craig, 1913; Nice, 1937; Laven, 1940). The work on the Herring Gull here described is to be followed by comprehensive experiments on other species as opportunity permits. The synthesis and comparison await the accumulation of adequate data for many species.

The experiments were made on Penikese Island, off the south coast of Massachusetts. A large part of the island contains a tern colony. One small point has a gull colony of about 400 nests. The work was done during the week of May 16-22, 1940. Mr. Donald R. Griffin arranged for accommodation on the island and assisted in the observations while continuing his own special research.

EXPERIMENTAL DATA

The technique consisted of changing the number of eggs in nests to find out if the bird would continue to lay. Each nest was num-

TABLE 1
EGGS ADDED TO NESTS

<i>Eggs laid</i>	<i>Number added</i>							
	<i>1</i>	<i>2</i>	<i>3</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>1</i>	<i>2</i>
3	2	4	1	0	0	0	0	0
2	3	4	5	6	11	4	0	0
1	2	4	3	5	1	0	7	8
0	1	0	0	1	2	0	1	3
	0			1			2	
	<i>Number in nest</i>							

bered and visited daily in the early morning. The number of eggs was recorded and then eggs were added or removed according to the history of the nest. A total of 171 nests was observed. Twelve of these were deserted or otherwise rendered unsuitable for experiments. Thus the contents of 159 nests were manipulated in this research. Since the birds were in the midst of laying, nests containing 0, 1, 2, or 3 eggs were easily found. The adults were not marked for individual identification.

TABLE 2
DATA FOR NESTS

Nest number	Eggs in nest	Eggs added	Eggs laid (May)						Total in nest
			17	18	19	20	21	22	
144	0	1	1	0	1	0	1	0	4
134	1	1	1	0	1	0	0	0	4
111	2	1	1	0	0	0	0	0	4
154	0	2	0	1	0	1	0	1	5
85	1	2	1	0	1	0	0	0	5
185	2	2	0	1	0	0	0	0	5
89	0	3	1	0	0	1	0	0	5
138	1	3	0	1	0	1	0	0	6

Table 1 gives the results of adding eggs to the nests. The abscissa indicates the number of eggs in the nest at the time the experiments began. The ordinate indicates the number of eggs laid after eggs were added. The figures at the top of the table show how many eggs were added. In all cases the eggs were added all at one time. Thus, for example, note the experiments in which two eggs were added to nests which already contained one egg. In eleven of these cases two more eggs were laid by the birds. Thus these nests contained five eggs at the end of the experiment. Typical results are listed in Table 2. These data establish the important fact that the birds were not restrained from laying when the nest contained three eggs. The critical cases are those in which two or three eggs were added and then more were laid. While possibly more than a day would be required to shut off the ovary, nevertheless continued laying is proof that the ovary cannot be restrained by the addition of eggs to the nest. The data in Table 1 also show that in no case did the bird lay more than three eggs, no matter what the number in the nest may have been. Those nests in which the bird laid less than three eggs may be explained by the factors of desertion, robbery, or termination of observations before the clutch was complete.

TABLE 3

EGGS REMOVED FROM NESTS

Eggs laid	Number removed					
	1	1	2	1	2	3
3	3	0	0	0	0	0
2	6	0	0	0	0	0
1	3	13	4	0	0	0
0	1	2	6	14	17	12
	1	2		3		
Number in nest						

TABLE 4

DATA FOR NESTS

Nest number	Eggs in nest	Eggs removed	Eggs laid and removed (May)						Total in nest
			17	18	19	20	21	22	
118	1	1	1	0	1	0	0	0	0
83	2	1	0	1	1	0	0	0	1
90	3	1	0	0	0	0	0	0	2
87	2	2	0	1	0	0	0	0	0
84	3	2	0	0	0	0	0	0	1
93	3	3	0	0	0	0	0	0	0

Table 3 gives the results of removing eggs from the nests. Each egg laid after the beginning of the experiment was removed so that the nests had the same number of eggs each day. The table is the same as Table 1 except that the numbers at the top refer to the number of eggs removed on the first day of the experiment. Table 4 shows some typical nest histories. These data establish the fact that in no case was the bird induced to lay more than three eggs by taking eggs from nests which contained more than one egg at the start. In three cases, after only one egg was laid, a nest contained three more eggs. These cases may be explained in several ways. The bird may have stolen eggs from nearby nests; the original bird may have deserted and another taken over the nest; a new clutch may have been started by the original bird. Possibly the ovary is so regulated that it can make up for the loss of an egg in the beginning of the laying period. These cases represent exceptions to the rule that the Herring Gull lays three eggs no matter how the number in the nest may be manipulated, if the above explanations do not apply.

In the other experiments the bird was not induced to continue laying by the removal of eggs. It seems more consistent to explain these three cases by some abnormality.

Evidence from other sources indicates that the Herring Gull is a determinate egg layer, depositing three eggs in a clutch. Both sexes incubate and have three distinct brood patches on the breast, one for each egg. Gross (1940) counted the eggs in 10,966 nests and found only two containing four eggs. Many of these nests had less than three eggs, probably due to incomplete clutches or predators. Goethe (1937) states, without giving the data, that if strange eggs are added to the nest, the female will continue to lay even though there are five or six eggs in the nest. Salmonson (1939), experimenting with Herring Gulls, removed the eggs as soon as laid. As many as sixteen eggs were removed from one nest during May and June. In most cases several successive clutches are included. In a few cases it is possible that the same female laid four eggs in one clutch. The author was not concerned with the problem of how many eggs are laid in a clutch but with the egg production in a season. He did not add eggs to nests. Gulls in general seem to have no perception of number. They commonly roll stones or sticks into the nest from nearby. Kirkmann (1937) found that *Larus ridibundus* would roll as many as seven eggs into its nest. These data support the conclusion from experiments that the Herring Gull is a determinate egg layer.

SUMMARY

During the laying period eggs were added to or removed from the nests of Herring Gulls (*Larus argentatus*) to ascertain the effect on the number laid in a clutch. The number of eggs was manipulated in 159 nests. The birds were not induced to lay more than three eggs by the removal of eggs nor restrained from laying three eggs by the addition of eggs.

The Herring Gull therefore is a determinate egg layer, whose hypophyseal-ovarian mechanism is fixed to produce three eggs in a clutch. This type of egg layer is contrasted with an indeterminate egg layer. Such species continue to lay until the nest contains a certain number of eggs, thus responding to an external stimulus (visual or tactile).

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WATERFOWL POPULATION AT CLEVELAND, OHIO,
WINTER OF 1939-40

BY R. A. O'REILLY, JR., J. F. AKERS AND E. S. NEWMAN

INTRODUCTION

In the fall of 1939 the Herrick Ornithological Society of Western Reserve University undertook an extensive survey of the Lake Erie waterfowl population in the Cleveland region. This census is the first of its kind that has been attempted in this area. Although a number of records of the waterfowl of this region has been made in previous winters, these records have been scattered and incomplete with obvious gaps making them inadequate for any exact population study. It was desired to find the order of migration, the true wintering population, the composition of this population and the factors governing it.

Using methods common to field-population studies, the members of this group attempted to take a complete census of waterbirds every seventh day from November 5, 1939, to March 31, 1940. This program was varied only when weather conditions seriously hampered visibility. The month of November was included in order to present a picture of the usual fall migration, and to find its influence in determining the winter population. Also the order of arrival could thus be noted. The unusual ice conditions of Lake Erie, described below, made it necessary to prolong the study to probably abnormal length. Weekly counts were discontinued when a sufficient increase in numbers was observed to indicate that the winter birds were being supplanted or their numbers considerably augmented by migrants. Actual counts were made in the great majority of cases. However, when the rafts were too dense, or the fowl flying too rapidly, estimates were made, based on counts by tens. In these instances more than one observer participated.

The area selected was a fifteen-mile section of waterfront including the city of Cleveland, and extending into the residential sections both to the east and to the west. This area was covered by from one to five observers in an automobile every Sunday, beginning shortly after dawn. The least amount of waterfront noise and activity was encountered at that time. The recent completion of a lakefront highway makes virtually the entire Cleveland waterfront accessible. A few preliminary field trips showed that the ducks regularly frequented from three to twelve definite areas, depending on the ice, and that intervening areas were practically devoid of birds. This condition

persisted throughout the study. These areas were always visited in the same sequence and at the same time of day. The possible margin of error should be allowed for in this as in any bird census. Difficulty in making an exact count of the birds seen, as a result of poor visibility or the distance of the birds from the observers, presented a frequent variable. Changing ice conditions added further difficulty by concentrating or scattering the ducks.

In the preparation of the following data much valuable assistance was obtained through the cooperation of Miss Isabelle Hellwig, and M. T. Jollie, both in executing the necessary field work and in recording and analyzing the resultant data. This study was further made possible through the active interest of Dr. J. Paul Visscher, head of the department of biology at Western Reserve University who made available the department automobile, the recent gift of Mrs. S. Prentiss Baldwin.

THE AREA STUDIED

The area studied included fifteen miles of the south shore of Lake Erie from the Municipal Sewage Disposal Plant at East 140th Street or White City Park, southwestward eight miles to the mouth of the Cuyahoga River, west seven miles to a promontory approximately 100 yards west of the mouth of Rocky River.

Beginning one mile west of the mouth of the Cuyahoga, a stone breakwater extends five miles to the northeast, parallel to the shore, forming a channel one-half mile wide.

Three miles at the east end of the area and over four at the west end are characterized by a sheer bluff about 100 feet in height. The intervening area is filled-in land about ten feet above the water level.

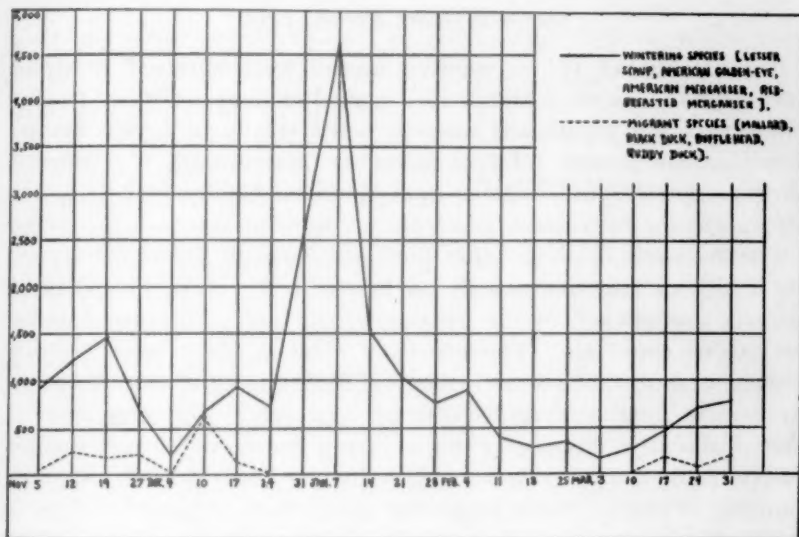
The entire shore is urban and suburban in aspect, and is further characterized by lack of any marshes or semi-aquatic growth.

ICE CONDITIONS

Ice conditions were found a perplexing factor, since they could not be adequately described or measured, and weekly changes exerted influence on duck population.

No ice was on the lake during November or December, and the migration of surface-feeding ducks (Anatinae) and some diving ducks (Nyrocinae) proceeded in a normal manner. However, the lake froze as far as the eye could reach in the first week of January, and it is assumed that the rest of Lake Erie and the Great Lakes did likewise, closing all harbors, bays and other shallow waters. This coincided exactly with a heavy migration of diving ducks.

The area under consideration remained frozen from the first week of January through the third week of March. Open water was found at all times at three points where warm water is emptied into the lake from two illuminating plants and a sewage-disposal plant. The size of these areas varied from one-quarter to one-eighth of an acre, roughly estimated. South winds occasionally caused fissures in the ice not protected by the breakwater, and these were frequented by ducks as often as they occurred.



TEXT-FIG. 1.—Fluctuations in abundance of wintering and migrant waterfowl on Lake Erie at Cleveland, Ohio, 1939-40.

As yet no satisfactory method of measuring the ice formations has been found; however, the changing conditions are represented in a remarkable way by a graph of the duck population after January 1 (Text-fig. 1).

THE FALL MIGRATION

At the initiation of this survey evidence of the usual fall migration was obtained in the form of records of the Loon (*Gavia immer*), Pintail (*Dafila acuta tzitzihoo*), and large numbers of Horned Grebes (*Colymbus auritus*). The number of these birds observed after November 4 was very small, suggesting the closing of an early-fall migration period (see Text-fig. 1).

Later migrants included the Mallard (*Anas p. platyrhynchos*); Black Duck (*Anas rubripes*), Buffle-head (*Charitonetta albeola*), and Ruddy Duck (*Erismatura jamaicensis rubida*), whose numbers increased after the first of November until December 10, when a peak occurred. From mid-December on, migrant species were virtually absent.

In mid-November a large number of Lesser Scaup Ducks (*Nyroca affinis*), occurred for a short time, indicating a fall migration by some members of this species.

THE WINTERING POPULATION

After December 17, no migrant species were observed in consequential numbers until March 17, a period of three months. During this period the population was composed chiefly of Lesser Scaups, American Mergansers (*Mergus merganser americanus*), Red-breasted Mergansers (*Mergus serrator*), and American Golden-eyes (*Glaucionetta clangula americana*), given in the order of abundance.

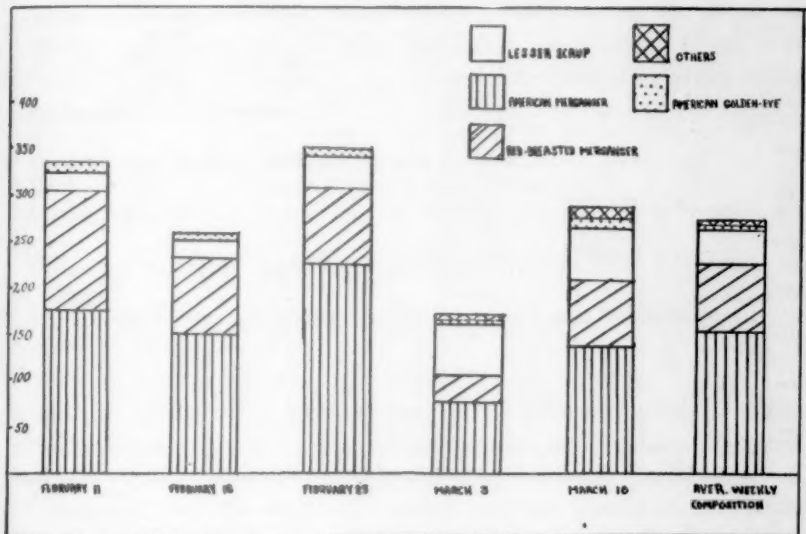
The numbers of these birds increased through December, reaching a high of 2628 individuals on December 31. The first week of January was marked by the freezing of the lake at Cleveland as far out as one could see. The few open areas available were literally covered with ducks and on January 7, 5417 waterfowl were counted, the largest number recorded on any one day. The suggestion is offered that the freezing of bays, inland lakes, and other shallow waters throughout the Great Lakes area may have forced out large numbers of ducks which otherwise would have wintered. This is in view of the fact that of the ducks identified on January 1 (4653), 97.7% were Lesser Scaups and American Mergansers. On this day long strings of American Mergansers were seen migrating eastward, 1500 being counted. The steady encroachment of ice on the available habitat was reflected in the sharply decreasing numbers of these species throughout January and early February.

Beginning February 11, a new and static phase of the population began. At this time there was no open water in the area studied except at three places on the east side of the city where warm water is poured into the lake by utilities and sewage-disposal plants. The combined surface of these areas varied from one-quarter to one acre approximately. The population in these areas remained rather constant for five weeks, averaging 279 birds per survey. The stability of the composition of this population indicates that it was relatively free from migratory disturbance (Text-fig. 2). This is called the true winter population.

THE TRUE WINTER POPULATION

The birds recorded from February 11 through March 10 represent those individuals of the species described herein as wintering species, which actually remained at Cleveland after the minimum area of open water was reached. This number seems to have been physically limited by the available habitat.

Barring the artificial conditions created by the pouring of warm water into Lake Erie, no waterfowl would have occurred in the area



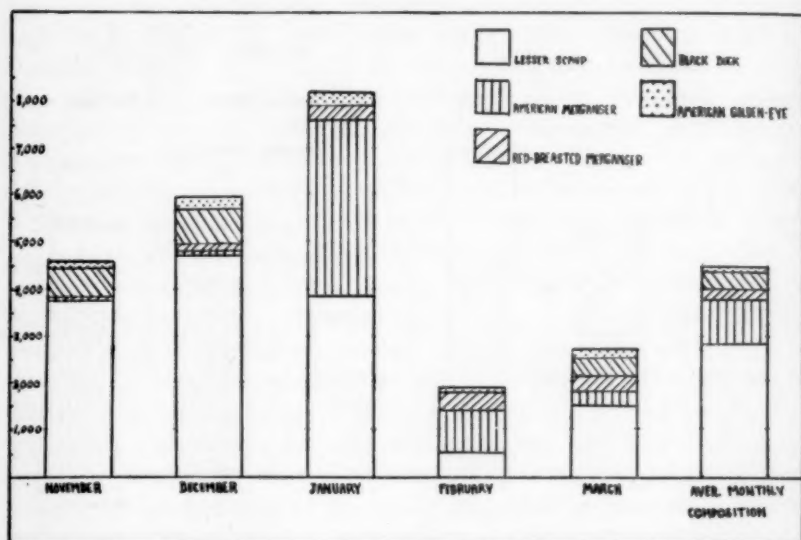
TEXT-FIG. 2.—Weekly analysis of the composition of the true wintering population.

at this period. This population which spent the most rigorous weeks of an abnormally long and cold winter here may indicate something of the relative resistance of the various species of wintering ducks. It is significant to observe that 82.1% of this population were mergansers, fish-eating ducks. Hence, food habits may explain the differences in the composition of the true wintering population (Text-fig. 2) and the general population observed throughout the winter (Text-fig. 3).

The greatest known cause of mortality in this population was a water intake at a powerhouse which accounted for at least 100 ducks. As these open-water areas were close to shore, the birds were continually exposed to missiles and occasional gunshots of vandals. The last factor doubtless drove away the more wary birds. Hungry gulls

prevented the determination of the cause of death by quickly disposing of all dead ducks.

Unfortunately no records were kept on sex ratio; however, when this constant population occurred and was observed repeatedly, it was evident that adult males comprised less than 10% of all ducks seen. In the American Golden-eye the ratio of adult males to females and immature birds was most nearly even. Approximate ratios for the Lesser Scaup were: adult males 1, females and immature 3; and for both mergansers: adult males 1, females and immature 24.



TEXT-FIG. 3.—General winter population analyzed by months, demonstrating its non-uniform composition.

In March many of the immature birds were observed changing into adult male plumage. These ratios were markedly different from those observed in the general winter population, and may present a factor governing the composition of the true winter population. On January 21, for example, a flock of 400 Lesser Scaups was seen, of which probably 300 were adult males. Again, on January 7, a flock of 1500 American Mergansers was seen, all of which were adult males. There is strong indication here of partial segregation of adult males, females, and immature birds (for example, comparatively many more adult-male Golden-eyes winter in the Cleveland region than adult male American Mergansers).

SPRING MIGRATION

The first indications of spring waterfowl activity were observed on March 3, when eight Black Ducks were seen, and on March 10, when a male Canvasback (*Nyroca valisineria*) was recorded.

Open water became gradually more available, and on March 17 the population had increased by over 61% of the true winter population, due to the influx of Lesser Scaups, Black Ducks, and Golden-eyes. This upward trend continued until the end of the study on March 31.

UNUSUAL SPECIES RECORDED

Below are listed species not previously mentioned which were recorded during the course of this survey, but whose occurrence is only incidental.

Canada Goose (*Branta canadensis*): March 31, one.

Redhead (*Nyroca americana*): January 7, one; 21, one.

Greater Scaup (*Nyroca marila*): January 21, one; February 18, one; March 10, one; 17, one.

Old-squaw (*Clangula hyemalis*): December 17, one; 24, one; January 21, one; 28, one.

White-winged Scoter (*Melanitta deglandi*): January 7, one; March 10, one; 17, one.

DISCUSSION

A study of waterfowl at Cleveland in the winter of 1939-40 showed two principal migration peaks in the fall and early winter. The first occurred on December 10, and was the peak for Mallards, Black Ducks, Buffle-heads, and Ruddy Ducks, called migrant species in this paper. A second and much greater peak occurred on January 7, when Lesser Scaups, American Golden-eyes, American and Red-breasted Mergansers reached their greatest abundance. These are called wintering species. Considerable spring migration was initiated on March 17.

A true wintering population exists, consisting of birds actually remaining at Cleveland throughout the winter. This minimum is guaranteed by artificially maintained open water. Since the size and composition of this population was relatively stable, migratory disturbance was seemingly absent from February 10 through March 11. The composition of this population was much different from that of the general winter population, which was probably more or less migratory (Text-fig. 4).

Factors governing the composition of waterfowl flocks off Cleveland are not all known. However, the lack of consequential numbers of dabbling ducks, except the Black Duck, is apparently due to the ab-

sence of suitable feeding grounds. The Black Duck seems not adverse to deeper waters, hence occurs in considerable numbers.

Fish-eating ducks seem to have a distinct advantage in maintaining their numbers in the face of the very adverse conditions caused by the low temperatures and limited feeding grounds prevailing in February and March. This is reflected in an analysis of the true wintering population (Text-fig. 4).

	MALLARD	BLACK DUCK	LESSER SCAUP	AMERICAN GOLDEN-EYE	BUFFLEHEAD	BOBBY DUCK	AMERICAN PIGEON	RED BREASTED PIGEON	
GENERAL WINTER POPULATION	00.2 %	07.9 %	62.3 %	02.9 %	00.1 %	00.2 %	20.9 %	05.5 %	100.0 %
TRUE WINTER POPULATION	00.7 %	00.4 %	19.3 %	02.3 %	00.2 %	00.0 %	53.8 %	22.3 %	100.0 %

TEXT-FIG. 4.—The compositions of the true and general winter populations compared.

The degree of freezing of Lake Erie in different years, which varies greatly, is expected to produce equal changes in the duck population. The coincidence of the influx of wintering species with the freezing of the lake suggests to us that these species may remain widely dispersed throughout the Great Lakes when no considerable freeze occurs.

Of the fifteen species of *Anseres* observed throughout the winter, four are classified as wintering species, four as migrants, and seven as incidental.

The above analyses are based on 23,000 field identifications.

The facts which have been presented in this study are considered an introduction to a problem the complete analysis of which will depend upon repeated observations in future years.

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Western Reserve University
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A THIRD SET OF JOHN ABBOT BIRD DRAWINGS

BY ELSA G. ALLEN

THREE times in the annals of American ornithology, each about twenty years apart, John Abbot has been brought to our attention in the pages of *'The Auk'*: first in 1896 (13: 204-215), when Walter Faxon described a set of 181 drawings which he said had "recently" come to light in the Boston Society of Natural History; again in 1918 (35: 271-286), when Samuel N. Rhoads reported on a second set numbering 122, which were purchased in 1906 for the Wymberley Jones de Renne Georgia Library¹ situated in an old colonial mansion on the Isle of Hope, Savannah. Rhoads believed that Abbot returned to England about 1810 and he exhorted us to further study on his life and work. Twenty years after Rhoads, Mrs. Victor Bassett took up the challenge, and we recall her enlightening article in the *'Auk'* for April, 1938 (55: 244-254), disclosing not only the fact that Abbot remained in this country until 1839, and probably died in Georgia, but also that he came here in 1776, some fifteen years before the date usually given for his coming. Perhaps in another twenty years the whole story of John Abbot, his paintings and his vast collections of specimens may be revealed to us.

In the meantime I have a few notes to add on a third set of Abbot bird drawings, which I chanced upon in the Manuscript Department of the British Museum in 1936. They form numbers 1137 and 1138 of the Egerton Manuscript Collection, which was the bequest of Frances Egerton, Earl of Bridgewater, in 1829. The set is in two large volumes, bound in green embossed morocco, and contains, according to the description in the catalogue of the British Museum "246 highly finished figures." They are described as "a most beautiful assemblage of the birds of Georgia in America accompanied with Description and the Latin, English and Georgian names in manuscript collected and painted from life by John Abbot of Savannah, splendidly bound by Lewis."

The volumes are dated MDCCCIV, while some sheets are watermarked Edmeads and Pine 1802. Others are watermarked J. Whatman and others are plain cartridge. The drawings had been mounted on heavy paper, with gilt edges, probably preparatory to being bound in the sumptuous covers of gold-embossed green leather. The first volume opens with a paragraph entitled "Remarks on the migration

¹ This library has recently become the property of the University of Georgia, at Athens, and Mr. W. W. De Renne, of the old De Renne family, is in charge of it.

of North American Birds" done in the most meticulous script and the drawings, no less, present a pageant of skill in observation from life as well as in execution by pencil and brush. Each drawing is accompanied by a careful description of the bird in life. As a rule the coloring is accurately and delicately done, though there are a few instances of too vivid coloration, as in the Blue Jay, which is bright sky-blue. All the yellows are particularly good, but Abbot had the same difficulty in drawing the eyes that he had in the De Renne set, for here, too, the high-light is too large and often placed forward, giving the bird an unnatural look. The Carolina Parakeet (Tab. 26), however, is an exception and is well drawn, as is also the Hairy Woodpecker (Tab. 52), showing the buffy, feathery tufts at the nostrils and the plain outer tail-feathers. Occasional inaccuracies are to be found, as in the Skimmer, *Rynchops nigra nigra*, which is represented without webbed toes, and the Water-Turkey or Snake-bird, *Anhinga anhinga*, with the hind toe not included in the web. I had hoped to make a careful comparison of this set of Abbot's drawings with those in the Boston Collection and those now owned by the University of Georgia, but it became necessary to return to the United States, and subsequent plans to continue these pre-Audubon studies in England have been cancelled with little expectation of being able to go back to them. Therefore, my notes are incomplete and the search for the source of these Abbot drawings and for information on John Abbot himself before he left England have been all but abandoned. However, I have been fortunate in having Mr. A. J. Watson, of the Manuscript Department of the British Museum, follow, during 1939, several possible sources of information and, for many of the notes I am about to give, I am greatly indebted to him.

The few articles on Abbot, including those in entomological journals and indices, emphasize Abbot's contributions to entomology and omit or mitigate his work on birds. It is indicated, however, that even in his early career in this country he was engaged to collect and delineate birds, as we may gather from a letter concerning Abbot shown to Mr. Watson when he enquired for Abbot materials at the Natural History Museum in London. This letter, dated March 23, 1917, was from a Doctor A. A. Mumford, of the Grammar School of Manchester, to Sir L. Fletcher, of the Natural History Museum, London, and mentioned that John Abbot was employed by the Chetham Library of Manchester between 1791 and 1802, to draw birds and spiders of Carolina and Georgia. At this time Abbot had been in America some fifteen years and was probably in his mid-thirties.

The only one with whom we know Abbot was closely associated in England was John Francillon, to whom he sent his drawings and specimens from America. Francillon was a jeweller and silversmith in the Strand, with a prominent clientele among whom were some of the royalty and nobility; he was also an entomologist delving in such minutiae as labial palps and coxae of insects, a combination of interests which seems sufficiently bizarre and yet which called for the same care and precision in workmanship. In one of the letters abstracted by Mr. Watson, John Francillon tells of meeting a Mr. and Mrs. Blackburn and showing them the jewels which he had prepared for the Prince of Wurtemberg. "He has appointed us his jeweller," said Francillon, and he went on to say that "we set his picture about three months ago very richly ornamented with Diamonds, which was presented (by his desire) to the King for the Princess Royal, which she now wears on particular occasions." As an offset to these royal commissions, Francillon took care of his large entomological collection, buying, selling, and exchanging specimens with scientists of England and the Continent.

It is difficult to learn anything about Francillon. His sales catalogue, published in London in 1818, yields nothing biographical, and the London Directories, including the Trade Sections for the years 1792-1809, which Mr. Watson examined, make no reference to him. However, a group of letters by Francillon to John Leigh Phillips of Manchester (Additional MS 29533) makes frequent references to this third set of Abbot bird drawings. This manuscript volume of letters, of which Francillon's letters are a part, was presented to the British Museum by Dr. John Edward Gray, Keeper of the British Museum, and, in addition to the Francillon letters of present interest, it contains letters by other naturalists—Dr. Daniel Carl Solander¹ (1736-1782), John Ellis (c. 1710-1776),² Bracy Clark (1760-1792), George Johnstone (1829-37), and others.

John Leigh Phillips of Manchester (1761-1814) was a very wealthy merchant who, although he died at the rather early age of fifty-three, helped many struggling naturalists from his private purse. Hence there is some likelihood that Phillips was one of John Abbot's sponsors, and that Abbot may have been an agent of the firm of

¹ Solander was a Swedish botanist who catalogued the natural history collections at the British Museum between 1760 and 1768, when he accompanied Sir Joseph Banks on Captain James Cook's voyage in the *Endeavour*. In 1773 he was made Keeper of the Natural History Department of the British Museum. He died in 1782.

² Ellis was a London merchant and became agent for West Florida in 1764 and for Dominica in 1770. Like Catesby, he sent many American seeds to England, and later imported them. He wrote a number of botanical papers, and some manuscript drawings by him are in the Linnaean Society, London.

J. Phillips of Manchester when he came to America. Be this as it may, we gather from Francillon's letters that Abbot made a set of 100 bird drawings, including eggs of many species, which, through the agency of a Mr. Bell,¹ were sent to Mr. Phillips of Manchester, and these are part of the set in the British Museum.

John Francillon's letter to Phillips is quoted below except for two lines at the end: (BM 29533, folio 75), dated London 3d October 1792.

"Dear Sir, I have sent you a Box per favor of Mr. Bell, who has kindly undertaken to send it with other things to you. The Box contains 100 Drawings of Birds of Georgia Drawn by Mr. Abbot of Georgia from Nature. I have shown them to Mr. Latham, who has examined them, and says they are correct, and are a true resemblance of the Birds, said if he collected Drawings he would certainly have purchased them. Mr. Latham said he was so satisfied with the Drawings, that he had wrote references to his own work on Birds (which you have seen) opposite to each discription which Mr. Abbot has wrote in his Catalogue, which I have inclos'd with the Drawings; the price is 6/- for each drawing, but if you chuse to purchase them I will venture to let you have them for 5/6 each. I think he will be satisfied with it by what he says to me in his Letter. No person has seen them except Mr. Latham. If you doo not chuse to purchase them please to endeavour to sell them to the Library, or any person you think likely to purchase them, and should they not sell at Manchester please to return them to me by the Waggon as soon as possible, as I must write to Mr. Abbot by the first ship that sails next week, and I shall be glad to inform him wether they are sold or not.

"Mr. Abbot is the person who collects insects so well, and (folio 75 verso) you are in possession of many of his collecting. He says he can complete about 100 more Drawings of other Birds, if the person who buys the present 100, chuses to give him the order to go on with them, and at the same price.

I am Dear Sir Your
most obd^t. Humb^l. Serv^t.
John Francillon"

We gather from this letter that the eminent English ornithologist, Dr. John Latham, who had recently published his 'Index Ornithologicus' (1790), thought highly of Abbot's work, and I recall he likewise makes occasional mention of his esteem for Abbot's observations in his other ornithological works. This letter indicates also that John Leigh Phillips was collecting bird drawings and other natural-history materials on his own behalf, and since he was a prominent citizen of Manchester, his manuscript letters may well contain matter of keen interest to ornithologists. Mr. Watson informs me that a manuscript volume of this purchaser (1791-1813) with about

¹ Perhaps a passenger on some ship to England. It was then customary to entrust one's packets to private individuals.

640 letters on all sorts of subjects is extant. A catalogue of his collections also is in the Chetham Library. These collections at the time of Phillips's early death, in 1814, were purchased by one T. Robinson, and when the Natural History Society of Manchester was formed, in 1821, these collections were purchased presumably from Robinson to form the basis of the Manchester Museum now housed at the Victoria University.

But apparently Phillips did not purchase personally the first consignment of 100 bird drawings by Abbot, for we read in Francillon's letter [Ibid. folio 48 v.] dated 21 November, 1792.

"I am extremely obliged to you for your great kindness in selling the Drawings of Birds, and I have wrote to Mr. Abbot to continue to make all possible addition he can with the Eggs to them agreeable to your instructions, and for the same price finish'd as soon as possible and as complete. I hope you will not take it amiss, as I plead for a poor Widow who is much in want at this time, to whom I am order'd by Mr. Abbot to pay the money too, as soon as I could sell them. I suppose Mr. Radcliffe will not take it amiss if you mention the reason for asking him for the payment of the 100 Drawings. But I shall leave it to your management whether to ask him or not."

Here we learn that the drawings were sold to a Mr. Radcliffe and the money for them was paid to some unfortunate connection of Abbot's probably a relative whom he was helping, but it is not stated whether this woman was in America or England. She was apparently in England, since there would not have been time to send the money to America after November 21, 1792, and receive thanks from her by December 22, 1792. On this date Francillon wrote to Phillips [Ibid. folio 79].

"I am infinitely obliged to you for your remittance of £ 27-10 for Mr. Abbot's 100 Drawings of Birds and the woman whom I pay the money too [sic] is much obliged likewise to you and Mr. Radcliffe, and the enclosed is my receipt for the same."

In a letter dated London, 2 September 1794 [Ibid. folio 84], Francillon wrote as follows:

"Mr. Abbot does not mention anything in his Letter concerning the continuing of Drawing the Birds, but I dare say he means to continue the work and I have this day wrote to Him on the [folio 84V.] subject."

At this time in his career (1794-95), according to Mrs. Bassett's article (*Auk*, 55: 248), John Abbot became prosperous. Slave labor became available to persons in more moderate circumstances in upper Georgia, following the invention of the cotton-gin, and Abbot is said to have owned "several slaves and to have had a comfortable and commodious home."

Whether these better circumstances prevented him from sending more bird drawings to Francillon, or whether in truth they were sent and somehow were not mentioned in these letters is not clear. At any rate, Francillon's next letter with regard to the bird drawings is dated London, 1st November 1805. Here Francillon wrote to Mr. Phillips [Ibid. folio 96]:

"With respect to the drawings of Birds which I sent you the other Day, I can settle with Mr. Abbot by the first ship that sails after Christmas, I was obliged to send away my Boxes by a ship that sailed for Charleston last week."

By this time Abbot had introduced some conventional devices in the composition of his drawings, which his clients in England did not approve, and Francillon argued in his behalf as follows:

"... I am sorry that they are not approved of. I believe the Birds are as well drawn and colored to nature as those that have been sent to you before; the Plants, Stumps and Moss are not given as fine drawings, but only something for the bird to stand or perch upon. If they had been good drawings of plants &c &c it must have greatly enhanced the price, I suppose at least double. I should have liked them plain colored bare twigs, or stumps without leaves, of a brown color and very simple, which I think would have shown the Bird better and saved Him much trouble, but has [sic] he had began the drawings on this plan of color'd Plants, Stumps & Moss, He must now go on with it so, those who see them should only examine the Birds, and look upon the rest merely to carry or support the Bird. [folio 96 verso]. I think it a great pity now (as the Gentlemen of the Library are so far advanced with them) not to have the whole as far as Mr. Abbot can find subjects to draw, which I think cannot be any more now, and it will render it complete being the drawings of one Man, and of one Country. As the Ship sailed sooner than I expected to Charleston, I ordered Him to proceed with them, not imagining there would be any alteration to the contrary, therefore if the Gent^l. of the library should determine not to have any more, please to inform me as soon as you can after Christmas, and I will write to Mr. Abbot by the first Ship that Sails. As there cannot now be a great number wanting to complete the Birds of that Country, I think it a great pity to discontinue this work, but this I must submit to your and the Gentlemens better Judgement."

It appears from subsequent letters that the "Gentlemen of the Library" for whom Phillips was negotiating, finally agreed to have Abbot complete the whole set of the birds of Georgia, for on January 13, 1806, Francillon wrote to Phillips [Ibid. folio 98]:

"I am very much obliged to you for the pains you have taken in settling with the Gentlemen of the Library to continue to take the remainder of the Birds. I will write to Mr. Abbot by the first ship [sic] and request He will take more pains with the drawings in future."

It is impossible to glean a consecutive history of these drawings at such a distance and at such a difficult time for research, but it may

be well to record such of the shifts of ownership as are so far known. The first consignment of 100 drawings we know went to Mr. Radcliffe and subsequently, after circuitous wanderings, came to the British Museum. The original cost was £ 27-10-0, after which there is an item listed in the archives of the museum of £ 8-8-0 for inlaying and binding. In 1795, apparently, an index was made at a cost of 3s-6d but this has been lost.

The last consignment of these Abbot drawings mentioned by Francillon is in a letter dated London, December 26, 1809 [Ibid. folio 104]:

"I have the pleasure of enclosing to you forty-four more drawings of Birds for the Manchester Library which I have just received from Mr. Abbot of Savannah, Georgia which I hope will be approved of and I have inclosed a Bill with them, and if not inconvenient to the proprietors of the Library I shall be obliged to them to favor me with the amount as soon as it may suit them, as I shall very soon have an opportunity [sic] of remitting it with some other money and articles in a Box to Mr. Abbot."

These two consignments total 144 drawings of birds by Abbot in the British Museum, but the set numbers 246 drawings so that 102 others were received at some other time.

The drawings passed out of the possession of the Manchester Library and became the property of one John Dent; they were again sold at auction in 1827. After this Philip Hurd bought them for 57 guineas. They were sold again at auction by Evans of New Bond Street July 30, 1845, and finally were purchased for £ 43 by the British Museum for the Egerton Collection.

While these drawings and their wanderings do but very little toward piecing out John Abbot's little-known biography, they are interesting as another ornithological incunabulum, and they are significant in that they offer suggestions for further lines of research, for, in tracing the vicissitudes through which an old manuscript passes, we may at any turn of the tortuous path come upon facts or leads in the author's life and work.

We know from Sir James E. Smith, founder of the Linnaean Society of London and purchaser of the Linnaean collection, that John Abbot started his career by the study of the transformation of British insects. He was one of the few who understood the preservation of caterpillars, by "stuffing"¹ them, and it is said that when he was about thirty² years of age he had gained sufficient reputation as a student of

¹ Jan Swammerdam (1637-1780), German entomologist, also practiced the inflation of insects by means of fine glass tubes filled with wax or other fluid.

² According to W. Horn and S. Schenkling, 'Index Litteraturae Entomologicae,' Berlin Dahlem, 1928, Abbot was born about 1760. This would make him only sixteen years of age at the time of his arrival in America, in 1776, which seems unlikely.

insects to be engaged by some leading entomologists to go to America. Who these men were, we do not know, but it is probable that John Leigh Phillips aided him in this enterprise. Likewise the ornithologist and entomologist, William Swainson, who travelled extensively in South America and ended his days in New Zealand, was his friend and correspondent. Possibly he left letters from Abbot in that far-away country, which would throw new light upon Abbot's associates.

The presence of three sets of Abbot bird drawings all purporting to be originals in three widely separated libraries calls for some explanation. Certainly their superficial appearances are different but the same little details of execution are present in all and it seems reasonably certain that Abbot's hand and brush did the bulk of the work.

According to his friend, William Swainson, this indefatigable collector may have employed one or two assistants to draw and paint for friend and correspondent. Possibly he left letters from Abbot in that they did. Thus their plates often passed as Abbot's own work, but, according to Swainson, the "originals of the master are readily distinguished by the experienced eye."

It seems more than likely, though, that he must have had help with the care of his insects. He is said to have raised them in captivity; this meant studying their food and environment so that these could be approximated in cage life. It should be remembered that not only the adults but also the eggs, larvae and pupae of each species were sent together with accurate drawings of the various stages. Furthermore, the specimens were not dried and poisoned but inflated in life-like appearance by means of tiny instruments and the preserving fluid.

Of one shipment alone, according to a letter from Francillon dated London, 10 August 1793, we read [*Ibid.* folio 81v.]:

"I have received from my friend at Savannah Georgia (the person who drew the hundred Birds) a wonderful fine collection of Drawings of the Insects of that Country the contents are 1021 sheets of Drawings, containing 1664 different species or 1833 figures with a manuscript description of the natural history of each insect."

This represents a prodigious amount of work. The price mentioned for the drawings was 8/6 while his price for specimens was sixpence, certainly not a high figure considering their meticulous perfection. Francillon, the silversmith, was, so far as we know, the only intermediary through whom Abbot's orders passed to the large museums of England and the Continent.

Parts of these vast collections of insects went to London, Dublin, Paris, Zurich, and Berlin. His bird paintings lie in London, Boston, and Athens, Georgia—possibly other places too; and we know at least one of his professional connections—the Chetham Library of Manchester. All these varied archives may prove to be productive sources of new information on this unsung, yet talented, artist of bird life, when peaceful mousings may again be resumed.

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GENERAL NOTES

The name of the Mexican Tiger Heron.—The name of *Heterocnus cabanisi* Heine (1859) has long been in use for the Mexican Tiger Heron. Unfortunately, it must be discarded because of the prior *Tigrisoma mexicana* Swainson (1834). In Murray's 'Encyclopaedia of Geography,' the zoological portions of which are by Swainson, there appears the above name, accompanied by the unmistakable description of an immature *Heterocnus*, together with an identifiable woodcut. Sherborn cites this name from the London (original) edition which I have not seen and which appeared in July, 1834. This was apparently issued in a single volume, while the two available American editions (Lea and Blanchard, Philadelphia, 1839 and 1841) are in three volumes, each paged separately. The two races of the Mexican Tiger Heron should therefore stand as:

Heterocnus mexicanus mexicanus (Swainson)

Tigrisoma mexicana Swainson, in Murray's Encl. Geog.: 1383, 1834 [Am. ed., 3: 315, fig. 1034, 1839]—Real del Monte (Hidalgo), Mexico.

Heterocnus mexicanus fremitus van Rossem and Hachisuka

Heterocnus cabanisi [sic] *fremitus* van Rossem and Hachisuka, Proc. Biol. Soc. Wash., 50: 161, Sept. 30, 1937—Guero-coba, Sonora, Mexico.—A. J. VAN ROSSEM, University of California, Los Angeles, California.

Note on *Corvus ultramarinus* Bonaparte.—In May, 1825, in the Journal of the Academy of Natural Sciences of Philadelphia [4 (2): 387], Bonaparte named as *Corvus ultramarinus* the species of jay described two years later by Swainson as *Garrulus sordidus* and by Wagler as *Pica sieberii*. That Bonaparte's name applies to a large race of this species ("tail seven inches") has never been questioned and only the circumstance that the describer endowed his new bird with a "perfectly even" tail-tip led to its abandonment by recent authors in favor of one of the 1827 names. I believe that the earliest name should be revived for reasons presented below.

Bonaparte's original employment of the term "even tail" must be taken in a comparative, rather than a literal sense for he compared his bird with "*Corvus floridanus*," a species of excessive tail graduation. Concrete evidence of what he considered to be an even tail is provided in a much later publication, his 'Conspectus Genera Avium.' In that work (Pt. 1: 378, 1850) his treatment of *Cyanocitta ultramarinus* and *Cyanocitta sieberi* is a badly scrambled combination of references and descriptions. Under "[*Cyanocitta*] *Garrulus ultramarinus* Bp. Pl. col. 439. ex Mexico" there is no reference to his original description. The individual described in the 'Conspectus' is, however, not the one figured by Temminck and Laugier (Nouv. Rec. de Planches Col.: 439, Sept. 22, 1827) but an example of the small race later named by Kaup as *Aphelocoma wollweberi*. This specimen, he states, has an "even tail." Actually, the lateral rectrices are 13 millimeters shorter than in the rest of the series. So much for the "even tail" of *ultramarinus*. The succeeding species, *sieberi*, he described as very similar to the preceding but larger and with tail rounded. But the specimen he used for this comparison is the identical one which is the basis of plate 439, and whose "rounded tail" consists of a lateral graduation of 20 millimeters!

Both specimens which Bonaparte used for his 'Conspectus' descriptions are extant in the Rijksmuseum van Natuurlijke Historie at Leiden, where I examined them in June and again in August, 1939. There is no question of their authenticity, and particulars as to their use have long ago been made public by Schlegel (Mus. Pays-Bas, 1 (livr. 9): 64, 1867). Essentially the same information is written on the stands on which the birds are mounted. The individual used as the basis for plate 439 (Bonaparte's reference) and of his description of "*sieberi*" is a good example of the large south-central race (wing, 181 mm.; tail, 172). The other, the basis of the description of "*ultramarinus*," is, as before stated, *wollweberi*. Because of the wording of Temminck and Laugier's text to plate 439, combined with Bonaparte's sole reference, the larger bird might conceivably be the actual 1825 type. However, Schlegel, a contemporary and co-worker of Bonaparte, makes no claims other than those set forth above.

The type of *Corvus ultramarinus* was sent to Bonaparte by a Dr. Samuel McClellan from an unspecified locality in Mexico, together with some specimens of *Cassiculus melanicterus* and a "*Fringilla grammaca*." Who Dr. McClellan was I have been unable to ascertain. His name does not appear in the indices of the few zoological publications of the period and Mr. de Schauensee informs me that there is no record of any association with the Academy. The most likely assumption is that he was one of the several medical men connected with American mining activity in southern Mexico and who were mentioned by Bullock ("Six Months Residence and Travels in Mexico"). One of the co-types of *melanicterus*, described at the same time as *ultramarinus*, has been examined at the Paris Museum and shows no indication of having been in captivity. It seems not unlikely that both species were from the same general locality, and I suggest Temascaltepec as one which will accommodate the few known facts plus the circumstantial evidence.—A. J. VAN ROSSEM, University of California, Los Angeles.

A new crow from Arizona.—For many years the crow has been known to occur in the Mogollon Plateau region of Arizona, and it has been assumed that these crows would necessarily be of the race *hesperis*, which was supposed to range through the western states to the exclusion of all other races.

In January, 1940, my friend, Lyndon L. Hargrave, secured a small series of crows at a camp in Burnt Corral Wash, on the Fort Apache Indian Reservation, Arizona. He at once found that these birds did not correspond to the description of *hesperis*. He called this fact to my attention, but had no opportunity to work out the problem personally.

In studying this problem, I briefly examined the specimens in the United States National Museum in August, 1941, although time did not permit the measuring of a series. A few months later I was privileged to make a more detailed study of those in the American Museum of Natural History. To the authorities of these two institutions, as well as to Hargrave, I am greatly indebted.

Crows from the western United States generally, at least from Okanagan, British Columbia, south to Las Vegas, New Mexico, and to San Diego County, California, are small, as pointed out by Ridgway, and to them belongs the name *hesperis* (type locality Fort Klamath, Oregon). The present writer failed to examine the type specimen, but it is clear that the race to be described below does not range as far north as Oregon.

The distribution of crows in the western interior is by no means continuous. South of the northern halves of Nevada, Utah, and Colorado they are local in

occurrence, at least as breeding birds. The southern limits of *hesperis* as a breeder seem to be near Santa Fé, New Mexico, and some of the highest plateaus of extreme northern Arizona. Farther south there is a belt of desert uninhabited by crows in the Coconino Plains—Little Colorado—Rio Puerco region. Still farther south, from central-western New Mexico west-northwest to near Williams, Arizona, is the faunally important Mogollon Plateau. About its lakes and grassy "parks" we find rather commonly:

***Corvus brachyrhynchos hargravei* subsp. nov.**

Mogollon Crow

Type.—Male adult, no. 562, collection of Allan R. Phillips; Burnt Corral Wash, 2 miles above Burnt Corral Ranch, Fort Apache Indian Reservation, southwestern Apache County, Arizona, January 8, 1940; L. L. Hargrave (orig. no. H145); shot by W. G. Duncan.

Subspecific characters.—Similar to *C. b. brachyrhynchos* of northeastern North America in long wing and tail, and thus larger than any geographically adjacent race; differs from *C. b. brachyrhynchos* in small, slender bill and tarsus, etc., as does *hesperis*.

Measurements.—Three males, wing, 328 to 334 mm. (or more); tail, 186 to 198; tarsus, 56 to 56.5; exposed culmen, 49 to 51. Three females (one of them not sexed but presumed to be a female from its small size), wing, 310 to 312 (or more); tail, circa 175 to 185; tarsus, 51.5 to 57 (or more); exposed culmen, 44.5 to 52.5 mm. One of each sex was measured by Hargrave and not seen by me, and due allowance has been made for slight differences in the method of taking measurements. Wing chord is the measurement used.

There is some apparently geographic variation in *hesperis*. Eight males and six females from Okanagan, B. C., average, respectively, 307.4 (293 to 319) and 298.5 mm. (290 to 305). Two males and seven females from Nicasio, Calif., give 284 (277 to 291) and 284.3 (271 to 299). Some of the latter I suspect may be incorrectly determined as to sex. With better material it may well prove necessary to separate a race in coastal California, but the limited material examined by me does not justify such a course at the present time. Eliminating the Nicasio "males," twelve males and twenty-two females of *hesperis* give a total range of 293 to 319 and 271 to 306 mm., respectively, in wing length. Tail measurements show similar trends but more overlap, and are more difficult to take.

Range.—The Mogollon Plateau region of Arizona and doubtless adjacent New Mexico. Probably winters mostly in valleys below the plateau "rim."

Remarks.—The new race is dedicated to Lyndon L. Hargrave in recognition of his efforts to stimulate ornithology in the southwest. The discovery that the size of the crow increases southward in the west is of interest. This is of course the reverse of a so-called "law" of geographic variation, but it is of frequent occurrence in birds which maintain the same zonal status in the southwest as in the northwest. This they do by inhabiting progressively higher altitudes, generally speaking, toward the south. Other species exemplifying this trend include the Hermit Thrush, Solitary and Warbling Vireos, Red Crossbill, Spotted Towhee, and the juncos.

The migrations of crows in the inland southwest appear slight, and almost no specimens are available as yet to determine their extent. Although very few of the specimens of *hargravei* examined were taken in summer, I have no doubt that

they represent the resident population of the region. It may be remarked, parenthetically, that *hargravei* is a rare bird in collections. There are a few in the U. S. National Museum, but I found none whatever in the American Museum of Natural History.—ALLAN R. PHILLIPS, *Cornell University, Ithaca, New York.*

Notes on Malaysian cuckoos.¹—While studying the material in the collection of the U. S. National Museum from the Greater Sunda area and particularly the west Sumatra islands, several points in the distribution and nomenclature of some of the Malaysian cuckoos have come up to which I would like to call attention.

Cuculus fugax fugax Horsfield

In his 'Handlist of Malaysian Birds' (1935, p. 123), Chasen has a footnote under *Hierococcyx fugax niscolor* Blyth to the effect that a form of this cuckoo occurs on Banka Island, southeast of Sumatra. It is perhaps worth while recording that there are two specimens in the U. S. National Museum (Nos. 180,513; 180,514) collected by Abbott in May and June, 1904, on Banka, which are referable to *Cuculus f. fugax* Horsfield, the resident bird of the area.

Rhopodytes sumatranus rodolphi, new subspecies

Type.—Ad. ♂. Acad. Nat. Sci. Phila. No. 56,255, collected Oct.–Nov., 1896, by J. Z. Kannegieter, Pini, Batu Islands, west Sumatra.

Description.—From *sumatranus* this race differs by larger size and a longer, stouter bill. Fourteen males of *sumatranus* in the collection of the U. S. National Museum measure: wing, 135.5–153 mm. (143.4); tail, 207–237 (221.4); culmen, 30–36 (33). The measurements of the type of *rodolphi* are: wing, 154; tail, 238; culmen, 38.25. Measuring the depth of both mandibles, I secured the following figures for the series of *sumatranus*: 13.25–14.5 (13.83); the depth in the type of *rodolphi* is 16. Comparing the measurements of length and depth by use of standard deviation tables, the result is greater than 3 in both cases (3.3, 5.1) showing that on the character of the bill alone, the larger size of the type is significant.

Discussion.—This is a wide-ranging species on the Malay Peninsula, Sumatra, and Borneo, being found from the mangroves up to four thousand feet, but the present record is the only one for the west Sumatra islands.

This race is named for my friend, Rodolphe Meyer de Schauensee, who is so interested in East Indian birds.

Riley (Proc. Biol. Soc. Wash., 51: 96, 1938) named a race, *minor*, from Borneo, on the basis of "averaging a lighter gray on the head, throat, and chest; the size smaller in comparison with *sumatranus*." The measurements of eight specimens, including the type of *minor*, fall within the range of measurements of *sumatranus* just cited. Birds from Peninsular Siam tend to agree with Bornean specimens in being very slightly paler gray on the head and throat. They are also in agreement in falling within the smaller range of measurements expressed in the series. However, considered by themselves, Bornean birds will not uphold the name *minor*. Even by lumping them with upper Malay Peninsula specimens, a difficult feat from the zoogeographical point of view, there is too much overlap in size and color to allow this separation.

Rhinorhina chlorophaea facta, new subspecies

Type.—Ad. ♂. U. S. Nat. Mus. No. 179,678, collected Feb. 20, 1903, by W. L. Abbott, Tana Massa, Batu Islands, West Sumatra.

¹ Published by permission of the Secretary of the Smithsonian Institution.

Description.—From *chlorophaea*, this race differs by larger size. The type measures: wing, 123.25 mm.; tail, 182; culmen, 29; tarsus, 28.5. A female collected August 24, 1896, by J. Z. Kannegieter on the same island measures: wing, 124; tail, 179.5 (worn); culmen, 30.5; tarsus, 28.5. A series of twenty males and females from Sumatra and the Malay Peninsula measure: wing, ♂, 110.5–119 (115.3); ♀, 110–119 (115.96); tail, ♂, 159.5–178.5 (167.8); ♀, 162.5–177.5 (169.8); culmen, ♂, 27–31 (28.97); ♀, 27.75–29.5 (29.07); tarsus, ♂, 26–27.5 (26.62); ♀, 26–27.2 (26.7).

Discussion.—The female from Tana Massa seems to differ slightly in color from any other female in the National Museum's series in that the gray on the abdomen looks purer with less of the buffy wash characteristic of the female plumage of this species. Probably, however, this is a case of individual variation. In this connection, I concur with Chasen and Kloss (Bull. Raffles Museum, No. 4: 32, 1930) in feeling that *fuscigularis* Baker, from Borneo, cannot be upheld. This race was founded on variations in the buffy wash in the female and the tone of rufous in the male, characters that tend to disappear in large series.

Centropus sinensis bubutus Horsfield

Chasen and Kloss (Ibis, 1926: 284) note that a specimen of the coucal from Siberut I., west Sumatra, is indistinguishable from Javanese specimens of *bubutus*. They remark on the gloss on the nape and neck which seems to be bluish rather than violet when compared with Sumatran and Malay Peninsula birds. I submit that this condition is due to wear and the state of plumage. Javan, Sumatran, Bornean, and Nias Island birds in the collection of the U. S. National Museum are indistinguishable in size or color. It seems best, therefore, to make *eurycercus* Hay a synonym of *bubutus* and include in the range of the latter, the Malay Peninsula, Sumatra, Nias, Siberut, Borneo, North Natuna Ids., Palawan, Balabac, and Cagayan Sulu.—S. DILLON RIPLEY, U. S. National Museum, Washington, D. C.

Ticks affecting birds' eyesight.—In 'The Auk' for October, 1941, Ruth Harris Thomas gives some interesting observations on the apparent blinding of small passerine birds by large ticks affixed to their heads in the eye-region. These ticks "flopped and swung with every turn of the head," it being concluded that unless the birds were consumed by predators, they eventually became totally blind and died of starvation.

In this connection it is of interest to record the case of a Myrtle Warbler (*Dendroica coronata*) that was found dead by Richard G. Kuerzi at Myrtle Beach, South Carolina, on January 8, 1940. A live tick of the *Ixodes* group was affixed to the head at the base of the upper mandible. It was well-engorged, measuring 5 mm. long and 4 mm. wide.

Post mortem examination of the bird revealed no signs of external injury. Subcutaneous dissection showed that the superficial tissues of the affected side of the head were the seat of profound extravasation of blood, this condition extending in a posterior direction for half the length of the body on that side. The blood was not fully clotted, but had a consistency such as slime.

Muscular development and general nutrition were normal. There were intra-abdominal hemorrhages, and the lungs showed partial consolidation. The heart was grossly normal. Other viscera showed advanced decomposition. The bird had been feeding on bayberries.

Gross diagnosis of ectoparasitism, debilitating pneumonitis, and terminal fatal trauma was made. This was the first case in my post mortem series in which

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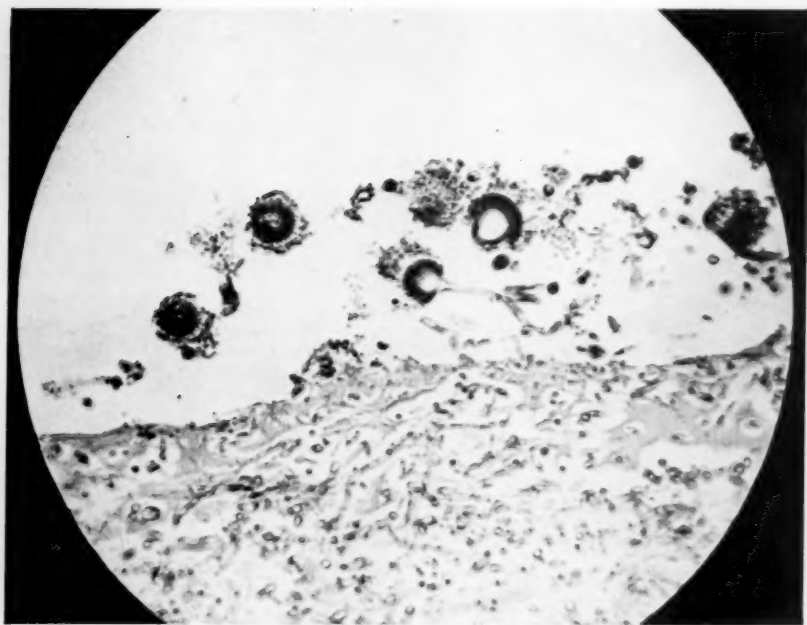
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Meade and Stoner: ASPERGILLOSIS IN A SNOWY OWL.
(Upper) STOMACH, HEART, AND SECTION OF LUNG. (Lower) PHOTOMICROGRAPH
OF LUNG TISSUE.

I regarded ectoparasitism as a primary cause of death. Thomas's cases, in which blood welled from the point of removal of ticks, would tend to substantiate my conclusion. It seems clear in combining my findings with hers, that the ticks secrete an anticoagulant, probably to facilitate their feeding. But in my opinion death results not so much from blindness and starvation as from the severe subcutaneous disturbances induced by the ticks.

It is an interesting observation that these large ticks have a predilection for the head region of small birds. Mr. Kuerzi subsequently sent me specimens as follows: a tick removed from the auricular region of a White-throated Sparrow; a Mockingbird bearing one tick between the eye and the base of the bill and another in the auricular region; a tick removed from an adult male Purple Finch in the auricular area just below and back of the eye; a tick from the auricular region of another adult male Purple Finch; and a tick from the auricular region of another White-throated Sparrow. All these specimens were obtained at Myrtle Beach, South Carolina.—C. BROOKE WORTH, *Swarthmore College, Swarthmore, Pennsylvania.*

Aspergillosis in a Snowy Owl (Plate 18).—During the incursion of the Snowy Owl (*Nyctea nyctea*) into the United States in the winter of 1941–42, a specimen was secured near Albany, New York, which proved to be heavily infected with the fungus *Aspergillus*. Following is a brief history of the bird.

The owl was captured alive on November 15, 1941, on the Carl Wilson farm near South Cambridge, New York, about thirty miles northeast of Albany. It was taken by hand by Mr. William Ibbott and two companions. They stated that the bird was on the ground, that they simply "closed in on him" and that he was "dangerous." These details suggest that the owl may not have been in a healthy condition at the time of capture.

Within a few days the owl was placed on exhibit in the window of a public market in Troy, New York. According to the proprietor of the store, the bird at first was fairly active and alert. However, it refused to eat meat or other food during the period of captivity and died on December 5, 1941, twenty days after it was taken in the field. It was received and examined grossly by Stoner on December 9.

This examination revealed that the subject was an emaciated male weighing 35 ounces (normal weight 48–72 ounces). The measurements, in inches, are as follows: length 21.5; wing 16.4; tail 9.4; tarsus 1.2. This bird is preserved as a study skin in the zoological collections of the New York State Museum, Catalogue No. 6274.

On opening the body cavities all the serosal surfaces were found to be profusely studded with small, round, whitish nodules. The parietal and visceral pleural surfaces of both lungs were heavily involved as were the epicardium and peritoneum. One or two discrete lesions were present in the capsule on the under surface of the liver. Discrete nodules were present in the mediastinum lying along the trachea and the great vessels of the neck. One of the largest discrete nodules was a flattened one lying adherent to the upper third of the left clavicle—it appeared to be in the periosteum.

The individual lesions were generally round, whitish-yellow in color, from 1–5 mm. in size, and fairly firm in consistency; some seemed almost calcareous and tended to shell out. Sectioning of the lungs revealed that both were extensively invaded. The parenchymal tissue was filled throughout with a myriad of discrete,

tubercle-like lesions and the intervening tissue was moist and firm. Unfortunately it was impossible to obtain cultures from the tissues before they were placed in fixative. For this reason the species of *Aspergillus* could not be determined.

Plate 18, upper figure, shows the gross appearance of the stomach, heart and a section of lung (after fixation in formalin). The lung section shows a transverse surface of the lung parenchyma above and the pleuro-peritoneal surface below. The numerous tubercle-like lesions are apparent. Lower figure is a photomicrograph of a section of lung tissue showing typical *Aspergillus* mycelia and conidiphores lying in the pleura.

Although Aspergillosis is known to occur fairly frequently in birds, particularly strigiform and anseriform species, it seems worth while to record this instance of its presence in a wild individual which had traveled several hundred miles beyond its normal range. It is possible that the Snowy Owl here reported may have become infected after its capture. However, the fact that the owl could be taken by hand and the very extensive inroads which the disease had made only twenty days after the subject had been captured, suggest that the infection was present prior to the beginning of the period during which it was held in captivity. This latter point also is supported by the fact that this bird was infected with the nodulo-tubercular form of the disease which, according to Fox ('Diseases of Captive Wild Mammals and Birds:' 558, 1923), is the most slowly progressive and chronic of the three forms occurring in birds.—GORDON M. MEADE, M.D., *Strong Memorial Hospital, Rochester, New York*, and DAYTON STONER, *New York State Museum, Albany, New York*.

Two new bird records for Utah.—The Bear River Migratory Bird Refuge has contributed many interesting records to the list of Utah birds, but few were more unexpected than that of a male Red-headed Woodpecker (*Melanerpes erythrocephalus*) collected by the writer on August 26, 1941. The bird seemed very much out of his element, as well as out of his range, as he perched on a wooden spill-box in Unit 2 with miles of lake on one side and more miles of alkali-flat desert on the other. He was, however, in fair flesh and feather condition.

Many an ornithologist has cast inquisitive eyes at the small terns which abound at the Refuge, hoping to identify the Common Tern (*Sterna hirundo hirundo*) among the common Forster's Terns. Presence of the species in Utah has long been suspected, but specimens which came to hand all proved to be Forster's Tern until on September 14, 1941, Mr. W. F. Kubichek of the Fish and Wildlife Service observed one of the species in the hospital that is operated at Bear River to care for birds afflicted with botulism. Mr. Kubichek's identification was verified by Dr. Clarence Cottam, and a specimen was made of the bird. Subsequent field observations indicated that during this period of fall migration the Common Terns were about one-fourth as common as the Forster's Tern.—CECIL S. WILLIAMS, *Fish and Wildlife Service, Brigham City, Utah*.

Mexican Dipper in the Huachuca Mountains, Arizona.—The range of the American Dipper, *Cinclus mexicanus unicolor*, is generally considered to extend southward in the mountains of California, Arizona and New Mexico approximately to the Mexican border. However, a specimen in Field Museum, collected by George F. Breninger in the Huachuca Mountains, Cochise County, Arizona, on May 28, 1903, proves beyond doubt to be a typical representative of the Mexican race, *Cinclus m. mexicanus*. This specimen (F.M. No. 14,994) is an adult female in clean, unworn plumage. It has been compared critically with adequate series of

adult *unicolor* and *mexicanus* and is found to be indistinguishable from the latter in all racial characters. The writer has been unable to find other specimens from the Huachuca Mountains but, since the species is non-migratory, the Mexican Dipper may be considered the resident form in that area and hence an addition to the A. O. U. Check-List.—EMMET R. BLAKE, *Field Museum of Natural History, Chicago, Illinois.*

Vermilion Flycatcher in Arkansas.—While walking along the shore of a large pond near Magnolia, Arkansas, on October 18, 1941, I caught sight of a red object near a clump of dead trees. As I approached, a small, brilliantly colored bird perched on a dead limb flew out over the water to catch various insects. Training my binoculars on him I soon recognized him as a Vermilion Flycatcher (*Pyrocephalus rubinus mexicanus*).

I was able to approach it very closely for it was apparently completely absorbed in its aerial contest with numerous insects hovering over the water. My bird had now flown farther down shore and was perched on a dead twig wagging its tail as he looked for insects. Like the Phoebe it did not resent my curiosity and I was able to study it at very close range. I soon saw the flycatcher was an immature male, for the red was just appearing in the crown and breast and its throat was white with red just coming through in spots. The breast had more color and the belly was a beautiful vermilion. Every now and then it would raise its crest and better show off its vermilion crown.

Having always associated this bird with the far west I was naturally puzzled at finding it in the southwestern tip of Arkansas far from its proper range. It is a resident of the arid regions of southwestern Texas, southern New Mexico, southern and western Arizona, southwestern Utah, southern Nevada, southeastern California and southern Mexico, wintering occasionally along the coast of southwestern California.

The bird stayed about the region throughout the week. Some ten days later, on October 28, while birding on the other side of the pond, I observed another one, this time an adult male with striking colors. The following day I observed both birds at once at the lower end of the pond where there were many dead trees surrounded by water and about these trees the flycatchers seemed to find an abundance of insects. A common Phoebe was also seen in company with them and provided an excellent contrast to its more colorful relatives.

A cold spell arrived and every day I expected the birds to leave but they lingered another week and on November 1, I decided one must be collected for it was apparently the first record of this bird for the state. With reluctance the immature male was taken on the afternoon of that day. The other bird lingered for two days of rather cold weather and was gone the following day.

A letter from Professor W. J. Baerg of the University of Arkansas stated that as far as the writer knew "there is no published record of the occurrence of this species in the state." It is therefore evident that the Vermilion Flycatcher collected at Magnolia, Arkansas, on November 1, 1941, is the first record for the State of Arkansas. This skin has been given to the ornithological collection of Cornell University at Ithaca, New York.—JOHN RIPLEY FORBES, *Former Director Kansas City Museum.*

Gambel's Sparrow in western Virginia.—To the casual occurrences in the eastern United States of Gambel's Sparrow (*Zonotrichia leucophrys gambeli*) we would add two records for western Virginia. The first was an adult male trapped and

collected by Handley at Blacksburg, Virginia, November 16, 1940. The specimen, which represents an addition to the Virginia list, is now in the collections of the Virginia Polytechnic Institute. It was the only individual of this race among 89 White-crowns trapped that fall. The second was a bird seen by Murray but not collected, at Cave Spring, on the Maury River near Lexington, Virginia, January 5, 1942. The bird was in high plumage, and was studied for some time at close range. The first of these records was made during a period when a severe blizzard swept the western states; the second after a very mild early winter, but after a blizzard had swept eastward just two or three days before.—CHARLES O. HANDLEY, JR., Blacksburg, Virginia, and J. J. MURRAY, Lexington, Virginia.

Food of some Utah birds.—The following report is based on an examination of the food contents of bird stomachs collected in Utah during the season of 1941. The writers were assisted in the collecting by E. R. Simmons, Dr. D. M. Hammond and T. Stanford.

A California Cuckoo, *Coccyzus americanus occidentalis*, was taken at Logan on June 10, 1941; its stomach contained 2 Hemiptera including fragments of a squashbug and a pentatomid of the genus *Brachymena*; 14 hairy and 2 smooth-bodied lepidopterous larvae. This bird supplies the second known record for Cache Valley.

A Nuttall's Poor-will, *Phalaenoptilus nuttalli nuttalli*, was collected at Tony Grove camp, in Logan Canyon, on July 28. Its stomach contained 6 adult Lepidoptera; 1 mirid bug; 2 leafhoppers; 4 Diptera; and 1 click beetle.

The stomach of a Rufous Hummingbird, *Selasphorus rufus*, taken among willows at Tony Grove in Logan Canyon, on July 28, contained 4 thrips; 10 aphids including 1 *Amphorophora ribiella* and 6 *Aphis* sp.; 1 Hemipteron; 1 Dipteron; 1 tiny beetle; 2 Hymenoptera including 1 *Trichogramma*.

One Red-naped Sapsucker, *Sphyrapicus varius nuchalis*, was collected in Mill Hollow of Logan Canyon on July 2, four were taken in Richards Hollow above Blacksmith Fork Canyon on July 9, and one at Tony Grove among fir and aspens. The food in the six stomachs consisted of 3 Homoptera including 1 scale insect, a *Cinara* sp. aphid, and a cicada; 17 beetles, including 2 weevils, 1 adult longhorned wood-borer, 2 scolytid bark beetles, 1 ground beetle; 1 Dipteron; 172 ants, more than half of these being carpenter ants; 4 spiders; 21 seeds. Besides the above, from 1 to 15 per cent (by volume) of the contents consisted of wood fiber and plant fragments.

Two Natalie's Sapsuckers, *Sphyrapicus thryoideus nataliae*, collected at Providence Lake on July 2, and one taken June 13 in upper Logan Dry Canyon, contained 4 beetles, 1 click beetle and 1 scolytid; 3 Diptera, 1 being a large crane-fly; 102 Hymenoptera, all but 4 of which were ants, many being winged and carpenter ants; also plant fragments.

Three Rocky Mountain Hairy Woodpeckers, *Dryobates villosus monticola*, were taken in upper Logan Dry Canyon on June 13, and upper Mill Hollow and Spring Hollow of Logan Canyon on June 20 and 25, respectively. Stomach contents consisted of 1 Hemipteron; 20 Coleoptera of which 10 were round-headed borer larvae and 4 larval flat-headed borers; 5 adult and 2 larval Lepidoptera; 22 Hymenoptera, all but one being ants; and plant fragments.

A Hammond's Flycatcher, *Empidonax hammondi*, collected in upper Mill Hollow of Logan Canyon, June 20, 1941, contained 1 leafhopper; 1 Hemiptera; 2 caddis-flies;

1 beetle, a bostrichid; 3 Diptera, 2 being bibionids; 3 Hymenoptera; and numerous fragments of other insects.

Three Wright's Flycatchers, *Empidonax wrighti*, were collected in Mill Hollow of Logan Canyon on June 18, July 3 and 15. Contained food consisted of 2 Hemiptera; 1 leafhopper; 1 stonefly; 3 adult caddis-flies; 20 Coleoptera including 1 click beetle, 1 scolytid, 4 leaf beetles, and 1 weevil; 1 larval Lepidopteron; 14 Diptera including 1 crane fly, 2 bibionids, 1 robber fly, 1 therevid; 10 Hymenoptera including 1 vespidae and 3 winged ants.

A Western Flycatcher, *Empidonax difficilis difficilis*, collected in Richard's Hollow between Logan and Blacksmith Fork Canyons, July 9, contained 1 Homopteron, the aphid *Mindarus abietinus*; 1 Hemipteron; 8 beetles including 2 weevils and 1 leaf beetle; 5 Diptera including 1 green-bottle fly; 6 Hymenoptera, including 1 braconid and a flying ant.

An Olive-sided Flycatcher, *Nuttallornis mesoleucus*, was taken in upper Mill Hollow of Logan Canyon on July 3; this contained 10 Coleoptera including 3 cerambycids, *Toxotus morio*, and 1 scarabaeid; 2 adult Lepidoptera; 2 Diptera; 4 Hymenoptera, 2 being ichneumonids.—J. S. STANFORD AND G. F. KNOWLTON, *Utah Agricultural Experiment Station, Logan, Utah.*

Food of the Ruddy Turnstone.—While returning from a boat trip to Bull Island, and Cape Romain National Wildlife Refuge, South Carolina, on November 11, 1941, the writer passed a power-boat on the Intercoastal Waterway pulling a large barge loaded with oysters being taken to market. The oyster barge was drawn about 60 to 65 feet behind the power-boat. A flock of 27 Ruddy Turnstones (*Arenaria interpres morinella*), working as individuals, and without apparent regard for others of their kind, were busy feeding on the small invertebrates—small mollusks, crabs, amphipods, isopods, and shipworms—that were adhering to the wet oysters. Repeatedly the birds were noted turning over the oysters in search of additional food.—CLARENCE COTTAM, *Fish and Wildlife Service, Washington, D. C.*

***Ilex opaca* as a late winter food for birds.**—Visits on March 9 and 23, 1941, to woodland areas near Wayside, Maryland, revealed that songbirds, in this portion of the southern Maryland peninsula, were concentrated in the several holly (*Ilex opaca*) groves of that area. Both resident and migratory species utilized these groves for shelter and as a source of food. On the former date, a single Red-eyed Towhee and several Bluebirds and Cardinals were observed swallowing *Ilex* berries, while at the latter time, a lone White-throated Sparrow joined hundreds of Robins in consuming these fruits. The large flocks of migrating Robins, seen then, perched several dozen in each pistillate tree and ate greedily from 7 a. m. to 1 p. m., with but a slight reduction in numbers and avidity during the latter part of this period. Although numerous on March 9, the holly fruits were perceptibly diminished in abundance by the afternoon of March 23.—GEORGE A. PETRIDES, *Conservation Commission, Charleston, West Virginia.*

Use of certain *Elaeagnus* species.—Several ornamental species and varieties of *Elaeagnus* with juicy, pink fruits have been introduced into the southeastern United States. Use of their fruit by birds for food has not previously been recorded. Because these plants have promise for erosion control, wildlife-habitat improvement, and human consumption, limited field collections were made recently by biologists of the Soil Conservation Service. It appears significant that all birds taken near *Elaeagnus* were found to be eating the fruit. Dr. Alfred Rehder, Curator

of the Herbarium, Arnold Arboretum, Harvard University, Jamaica Plain, Massachusetts, identified the *Elaeagnus* species referred to in the accompanying records.

Fruits of *Elaeagnus umbellata* var. *parviflora* ripen during July and early August, remaining on the plant from four to six weeks. This variety, which we refer to as 'summer *Elaeagnus*,' has escaped rather widely from cultivation into the woods near Raleigh, Pittsboro, and Charlotte, North Carolina, and Athens, Georgia. (There may be other localities where the plant is becoming naturalized, and if so, the author would be pleased to learn of them.) It appears to occur where birds have dropped the seeds beneath trees where the plant flourishes and fruits in an edge or semi-understory of partial shade. It also seeds naturally in old roadways, gullies, and similar sites where flood water doubtless aids in its distribution and natural culture. It is pleasing as an ornamental hedge and may be adaptable for use as a field hedge. The fruit of this species is used rather extensively in making wines and jellies. It is pleasing to the taste and is reported to be eaten by Domestic Fowl. The stone is not digested by birds—only the juicy fruit is of benefit. The silvery scales are easily identified in the stomach, as is likewise true of the stone.

The following records were obtained from stomachs analyzed by the author (the material is on file in the Bureau of Biological Survey, Washington, D. C.):

ROBIN, August, 1939, Floyd, Athens, Georgia.

CATBIRD, July 14, 1939, Hunt, Raleigh, North Carolina.

BROWN THRASHER, July 14, 1939, J. B. Hunt, Raleigh, North Carolina; July 21, 1939, Davison, Charlotte, North Carolina; July 27, 1939, E. V. Floyd, Athens, Georgia.

YELLOW-BREADED CHAT, July 21, 1939, Davison, Charlotte, North Carolina.

CARDINAL, August 1, 1939, Hunt, Raleigh, North Carolina; August 1, 1939, Floyd, Athens, Georgia.

The fruits of *Elaeagnus umbellata* ripen in October and remain on the plant until January, a period of eight to fourteen weeks. We refer to it as 'fall *Elaeagnus*' to differentiate between it and var. *parviflora*. The writer knows of its escape from cultivation in but two places—Spartanburg, South Carolina, and Mocksville, North Carolina. The following records were obtained from stomachs examined by the author:

EASTERN MOURNING DOVE, January 5, 1940, Pollock, Mocksville, North Carolina.

MOCKINGBIRD, October 2, 1939, Becker, Spartanburg, South Carolina; October 15, 1939, Davison, Spartanburg, South Carolina; October 20, 1939, Hunt, Franklin, North Carolina.

CATBIRD, October 2, 1939, G. B. Becker, Spartanburg, South Carolina.

ROBIN, January 5, 1940, Pollock, Mocksville, North Carolina.

EASTERN HERMIT THRUSH, January 2, 1940, S. Z. Pollock, Mocksville, North Carolina.

CEDAR WAXWING, January 2, 1940, Pollock, Mocksville, North Carolina.

Elaeagnus pungens var. *reflexa*, a species which remains evergreen in the southeastern states, ripens its fruit in late February and March. We call it 'winter *Elaeagnus*' to include the closely related species and varieties without confusion with the deciduous species. I observed Cardinals, Juncos, and other small birds eating the fruit of this or a related species in Atlanta, February 26, 1939. Again, at the same place on April 13, 1940, Cedar Waxwings, Brown Thrashers, and small birds were just finishing the crop which was both late and comparatively scant in 1940 after very severe winter temperatures. (In the upper Piedmont practically the whole crop was destroyed.) Beneath the trees near these plants,

the seeds were numerous from the droppings. This plant is reproducing naturally beneath the older bushes in Atlanta, Georgia, and at Clemson, South Carolina. It might be desirable in the field as well as an ornamental because of its evergreen foliage and spring fruiting but I am not yet familiar with its dependability for fruit or its adaptability to field conditions. I obtained the following stomach record:

ROBIN, April 11, 1940, Auburn, Alabama.

Since the three forms of juicy, pink-fruited *Elaeagnus* referred to above are preferred foods of many resident and migratory birds, they are being tested both in the nursery and in the field to determine their adaptability to sites for which shrubs are suitable in land-use patterns of southern farming, and the possibility of establishing them in hedges, on woodland borders, and in gullies by direct seeding alone or in combination with other shrubs.—VERNE E. DAVISON, U. S. Soil Conservation Service, Spartanburg, South Carolina.

Nesting habits of the Spotted Sandpiper.—The Spotted Sandpiper (*Actitis macularia*) is quite a common bird in Regina, Saskatchewan but the first occasion, in many years of study, which enabled me to keep definite and continuous data on the nesting habits, occurred in 1934.

On June 3, I discovered the nest in a field in which an attempt was being made to eradicate brome grass. There were numerous very light patches of the grass still growing, the rest of the ground being bare and loose. The nest was located to the north of a clump of this grass and 14 feet away from a thicket of lilac and ash trees which afforded a splendid windbreak as well as a screen for the purpose of making observations. The nearest open water was 450 yards away.

Although many details were noted, a summary of important events may be best.

June 3, discovery of nest; 3 eggs; both birds present.

June 4, 8:30 a. m.; 3 eggs; both birds present.

June 4, 5:15 p. m.; 3 eggs; both birds present.

June 5, 8:30 a. m.; 4 eggs; both birds present.

June 7, 8:30 a. m.; incubating; for the first time only one bird present.

June 20, 5:30 p. m.; for the first time 'injury feigning' was fully exhibited. On other occasions prior to this there were indications of it, but this was the first complete performance.

June 25, 8:30 a. m.; incubating; 'injury feigning'; no sign of hatching.

June 25, 12:15 p. m.; 2 eggs hatched, 3rd chipped.

June 25, 7:25 p. m.; all eggs hatched; one of the young damp and sitting on a portion of the shell.

June 26, 8:30 a. m.; nest vacant and family twenty yards from the nest.

The period of incubation, if commenced immediately the fourth egg was laid, could be considered as between June 5 at 8:30 a. m. and June 25 at 7:25 p. m., or 20 days.

The family remained within fifty yards of the nest until July 14, on which day two young and an adult were seen, but no trace of them thereafter.

I may say that, when the nest was found, I noted bearings and set inconspicuous markers. The following year (1935) a Spotted Sandpiper built on exactly the same spot that was occupied the previous year, although the field had been cultivated in the spring. The patch of grass sheltering the nest had survived and was quite similar to the previous year. My markers on the edge of the field for cross bearings were intact.

On June 8, the nest was complete with 4 eggs at 8:30 a. m.

On June 26th, at 8:15 a. m., one egg was hatched and at 7:30 p. m., on the same date, the nest was vacated. Incubation required approximately $19\frac{1}{2}$ days.

On June 30, after one hour and twenty minutes' search, I located the family with one adult. On July 21, the family was still in the home territory with one adult but was not seen thereafter. By imitating the call of the parent I was able to deceive the young and obtain some excellent photographs. The alarm signal was a strong *pett wheel* which caused immediate hiding and 'freezing,' while a softer *wheel*, often repeated and gradually diminishing, no doubt as the reunion progressed, brought them together.

With regard to 'injury feigning,' I do not wish to comment upon this at the present time. Attempting to analyze bird behavior according to human standards and modes of expression is a most difficult and hazardous pastime for a layman.

The habit of the adult perching on stumps and low bushes was much in evidence when they were caring for the young. While perching, the bird never stayed in one place more than a few seconds.

In 1935, after the young had left the nest, the birds were seen several times at 6:00 a. m., and shortly afterwards, making use of a shallow bird bath set flush with the ground fifty yards or so from the nesting site on the opposite side of the thicket.

It will be evident that I have made no mention of the sex of the adults. My opinion is that after the eggs were laid the male was the active agent in caring for the eggs and young. On one occasion only, after the young were hatched, another adult appeared in the home range and appeared passively but not actively interested in the young. This appearance quite probably was purely accidental.

In 1936 a pair of Spotted Sandpipers appeared on the site but did not nest.

From this record it would appear that the period of incubation is approximately 20 days. The weather during both periods was dry and warm. Other weather conditions might vary the time. The nest was vacated a few hours after hatching. 'Injury feigning' attained its height about five days before hatching and gradually diminished with repetition and the growth of the young. The young were protected in the home range for a period of approximately three weeks before leaving. There was not the tendency to wander far afield that I have seen in the Killdeer.—E. H. M. KNOWLES, Regina, Saskatchewan.

Swimming ability of young Catbird.—While walking along a bank of Fishing Creek near New Martinsville, Wetzel Co., West Virginia, on July 18, 1941, I startled a young Catbird (*Dumetella carolinensis*) from its perch so that it fell into the slowly-moving stream about four feet from shore. The bird, evidently just out of the nest, inasmuch as its short tail was barely evident, landed dorsal side up and with six or eight strokes of its wings was ashore again. Except for an initial cry as it lost its footing, it seemed little excited and, floating high in the water, it headed immediately for the nearest dry land. Its head and neck were never wet. Movements of the feet could not be seen.—GEORGE A. PETRIDES, National Park Service, Washington, D. C.

Great Black-backed Gull killing American Goldeneye.—On October 19, 1941, in the Ile au Héron Bird Sanctuary, Montreal, Quebec, my wife and I were examining a flock of ducks with a 7-power binocular and a 42-power telescope, when our attention was suddenly drawn to an adult Great Black-backed Gull (*Larus marinus*) on the far side of the flock. The gull was chasing a female American Goldeneye

(*Glaucionetta clangula americana*) with the obvious intent of capturing her. The pursuit continued for approximately ten minutes, with the duck using every means to avoid being caught, except that of flight. As she broke the surface after a short dive, the gull seized her by the tail and held on with great tenacity, despite the fact that by this time she was rapidly beating her wings and had partially risen from the water. Scaup and Goldeneye near by were undisturbed and continued to feed. An immature Great Black-backed Gull, a yearling, appeared to be mildly interested, and remained on the water a few yards away.

What immediately followed is pure conjecture, because the gull turned and faced in the opposite direction, holding its wings extended above its body; but we could see that it had pulled the duck into the water, had transferred its hold from the tail to the neck, midway between the head and body, and was killing it by shaking it from side to side and plunging it under the water. Then it released its grip, turned the duck over on its back, ripped it open, and for the next half hour gorged itself.

Two hours later we saw an immature gull of the same species kill a duck, but because of the great distance that separated us we were unable to identify the victim nor observe clearly the method the gull was using, but the result was the same.

During the summer of 1938, I visited the coast of Labrador as a guest-member of Dr. Harrison F. Lewis's party from the Dept. of Mines & Resources, Ottawa, Ontario, and there I soon became familiar with the methods used by the 'saddle-back' in capturing young eider ducks, but I have never observed, nor have I read of it taking anything very much larger.—J. D. CLEGHORN, *Montreal, Canada*.

Northern Pileated Woodpecker eating salmon.—On the evening of June 27, 1942, I set a wire box-trap for a cat at my home near Boonton, New Jersey. The bait for the trap was a piece of canned salmon wrapped up in a cheese-cloth. The trap was set at the edge of a wood road about one hundred yards from my garage. The salmon can was opened, the oil poured out, and small pieces of the fish were scattered about in the road in front of the trap. The next morning the trap was unsprung. Later in the day I was sitting in a semi-concealed spot when a Northern Pileated Woodpecker (*Ceophloeus pileatus abieticola*) was observed flying up the wood road. He passed over the trap, then wheeled and lit on the trunk of a tree about six feet away. Almost immediately he started hitching down the tree to its base, flew to the roadway and after a moment's hesitation began picking up and swallowing the bits of salmon. He followed their lead to the entrance of the trap but a slamming door frightened him off.

On a nearby tree I have a suet basket which is kept filled throughout most of the year. Although I have never actually observed the Pileated Woodpecker feeding from this basket he undoubtedly does for I have seen him fly from this tree on numerous occasions. The suet may have attracted him to this general locality. The fruit of the pepperidge tree, *Nyssa sylvatica*, appears to be a favorite food of this woodpecker for during the season when the fruit is ripe a tree in our garden is visited regularly by these birds.—T. DONALD CARTER, *American Museum of Natural History, New York, N. Y.*

Remarkable nesting date of the Everglade Kite.—In recent years the writer has spent considerable time in field work on the remnant population of the Everglade Kite (*Rostrhamus sociabilis plumbeus*) which now appears to be staging its last fight as a bird of this country about Lake Okeechobee, Florida. Small breeding

colonies there have been under vigilant care of Audubon Warden Marvin Chandler for the past several seasons and, as far as field work can reveal, there are no others in the state now. While the nesting season varies considerably in extent and date of commencement, it usually takes place from late February on through May. Howell states that, at times, nests have been found as early as January, and Bent in his 'Life Histories of North American Birds of Prey,' lists 68 breeding records occurring from February 15 to July 20. No breeding record after late July has hitherto appeared in the literature which is available to the writer. One would not expect any.

However, very recently the writer was the recipient of some amazing information from that state of amazements, Florida. Through Mr. Clinton C. Sherman, Jr., of West Palm Beach, a gentleman who has the good of Florida's bird-life much at heart, an ardent field observer, taxidermist, and sportsman, a new chapter has been added to the life history of the Everglade Kite. On November 2, 1941, while duck hunting in the marsh south of Clewiston on the south shore of Lake Okeechobee, he found three nests of this species! One nest held one egg and one newly-hatched chick; the other two nests held two eggs each. The writer in answering this letter, requested Mr. Sherman to watch this little colony and report on further progress. A letter, dated Nov. 12, has just been received which states that on Nov. 9 another trip was made to the locality and an additional nest discovered. This held three eggs. The former three nests then contained two young each, all having hatched since Nov. 2. In one instance the youngsters appeared to be about a day old.

The surroundings are unlike the grassy 'reefs' of Lake Okeechobee where the nesting colonies known to the writer occur. According to Mr. Sherman his nests, now four in number, are "in the middle of a large marsh of cat-tails, deer-tongue, pepper-grass and water lilies with a few scattering willow trees." He took several photographs of the nests and young which have not yet been received by the writer. This is an absolutely unprecedented occurrence, and utterly at variance with the usual nesting season. Recently, the National Audubon Society issued a pamphlet on the status of the Everglade Kite, primarily for distribution among Florida duck hunters, and Mr. Sherman has been very diligent in distributing these. The kite is a decided favorite of his and he has frequently urged his fellow sportsmen not to shoot the birds. He intends to keep a careful watch on this remarkable colony and will report how the youngsters fare. He has added a valuable piece of information on the ornithology of the Lake region, and the writer is indebted to him for making the information available.—ALEXANDER SPRUNT, JR., *The Crescent*, Charleston, S. C.

American Egrets nesting at high altitude.—The American Egret (*Casmerodius albus egretta*) is usually considered as breeding in semi-tropical, low-lying swamps, islands, keys, bayous and the like, of the southern states. True, in recent years it appears to have extended its range to the northward at least as far as Paulsboro, New Jersey, and has been known in the west for some years. However, as far as the writer is aware, the great majority of its nesting areas are characterized by either water-level elevation (sea level) or very slightly above that. Situated as he is at the present writing (Rockport, Texas), the writer is divorced from any contact with a reference library and has no recollection of egrets breeding at high altitudes. Therefore, the following should be of more than ordinary interest, and may constitute a 'high' in the nesting habits of this increasing species.

Audubon Warden H. C. Blanchard, of Brownsville, stationed usually in the Lower Rio Grande Valley of Texas, but currently patrolling the area about Corpus Christi, has furnished the writer with the following information. In the summer of 1938, he made a trip to the west coast from Brownsville, travelling by car through New Mexico and Arizona. As is his invariable habit, he kept a watch for birds on the way, and his long years of collecting and ornithological guiding in various parts of Texas and the west has accustomed him to such observation. While in the vicinity of Flagstaff, Arizona, he heard of a colony of egrets nesting not far off. He investigated this report in July, 1938, and found it to be authentic. He found twelve pairs of egrets nesting at what is known as Mormon Lake, Arizona, about thirty miles southeast of Flagstaff. He understood at the time that the elevation of this place was "about 7600 feet." The writer has communited with reliable sources in Flagstaff, and has ascertained that the exact elevation of Mormon Lake is 7000 feet. This would appear, in the lack of any additional information, to be the highest elevation at which the egret has been known to nest, at least in the writer's knowledge. The peculiar post-breeding-season migration of some of the herons has resulted in their being seen by the writer in the North Carolina mountains at elevations of at least 4500 feet, these being Little Blue Herons (*Florida caerulea*), but he has never seen an egret in the east at even this elevation, much less nesting thereat. Seven thousand feet is a considerable elevation for a bird of this species, and constitutes a most interesting record and item in the life history of the bird.—ALEXANDER SPRUNT, JR., Charleston, South Carolina.

A hummingbird migration.—In the case of most birds, both the method and the time of migration are hidden by the darkness of night, and usually our knowledge of their movements is summed up in the statement that they were here yesterday and now they are gone, or the converse, that yesterday there were none and now they are here. Even in the case of those we can see because they fly by day, except for the few reports from such favored localities as Point Pelee, Ontario, we know very little of times and ways. With no other bird are the foregoing statements more emphatically true than in the case of the Ruby-throated Hummingbird (*Archilochus colubris*), whose insignificant size removes him from our view before he has gone a hundred yards. Therefore it gave me a most pleasurable shock when I found myself with two capable assistants watching a daylight migration of those birds on August 30, 1936.

The locality was at the top of the cliff, some 150 feet in height on the north shore of Lake Erie, two miles east of Port Stanley, Ontario. This is the spot where we look each year for the autumn migration of hawks and we had actually gone there on that day hoping to see some of the first hawks, though feeling that we were probably too early. Hawks and some other birds turn west in autumn when they reach the north shore of the lake, and it is positively known that many of them cross the lake at Point Pelee, 100 miles west; it seems a fair assumption that they do so at Long Point and Rondeau also. Long Point extends about twenty miles east from the mainland, and the bay at that point is more than twenty miles from the land. At Rondeau the shore takes a dip toward the south, but no flight has been observed there. The observations of Mr. George North at Kingsville, some ten miles west of Point Pelee, in 1936, showed that all the hawks seen there were still going west. Whether all of those go around the end of the lake is yet unknown.

Now that most of our hawks have been killed, there are not enough left to

promise with any certainty that a visitor to the cliff will be rewarded on any particular day, but in the past we have seen some nice flights there. One of the great troubles in dealing with these flights is that they are uncertain, and as they occur about thirty miles from London, Ontario, the place is not visited with any regularity. While visits occur when there is no flight, flights do occur when there is no one there to observe them. The birds fly west above the cliff and the flight extends back from the lake for a mile in diminishing numbers.

And now the hummers have joined the western flight of migrants. No sooner had we arrived at the brow of the hill on the day in question than hummers began to be seen, singly for the most part, though often so close together that the one in front could be seen by the next. In a few minutes we had counted twenty-three. My companions were E. Melville Dale and my granddaughter, Kathleen Fetherston, who undertook the task of counting the birds as they passed, a task which proved to be no sinecure; in fact, after it was over, they thought that two pairs of keen eyes were insufficient to record all the migrants. In the first fifteen minutes they counted 83; in the next fifteen minutes, 52. By then it was fifteen minutes to six, and the flight was tapering off with the lowering sun. Yet there were a few hummers passing, for we saw another dozen before we got into the car and left, making a total of 170 hummers that we watched flying west in less than an hour. The conditions included a strong north wind which might readily inconvenience so small a flyer, and a threat of lowered temperature. Nearly all of the birds, except probably less than ten per cent, flew just below the brow of the cliff where they were sheltered from the force of the wind. The remaining few were seen flying above the cliff, even to fifteen feet above it, and followed exactly the same direction.

On the way south to the lake, we had stopped at a fine growth of jewel-weed, which has great attraction for these birds, and there we saw six of them feeding at the flowers. Since then, odd ones have been seen and our latest autumn date is in early October.

In 1906, Taverner and Swales recorded hundreds of these birds feeding at jewel-weed on Point Pelee on September 1, 2, and 3, which fully corroborates the date on which this migration of 1936 was witnessed, one hundred miles farther east. At Point Pelee the hummers fly to the south end of the Point, and then, dropping down to near the level of the water, they usually direct their course towards Pelee Island in the southwest and are out of sight in a moment. Almost every observer who has been at the Point at the proper date has seen a few of these birds disappear over the lake, but opportunities to watch their passage over the land have been so rare as to be almost unheard-of; in fact, I do not recollect having read of any such flight. It may be that the north shore of Lake Erie offers an exceptional opportunity to observe them in late August and early September.

Since 1936 we have attempted to repeat this observation almost every year, but there has been no occasion when all the conditions have been fulfilled,—namely, the proper time on the calendar, a strong north wind, and a clear day. Several times we have been at the spot, eagerly looking, and once, on September 10, 1940, we saw a few migrants, of which we counted twenty-one; on the other days we drew a blank. But never shall the end of August come without our thoughts going back to that spectacular day with its one hundred and seventy hummers in less than an hour. Besides the hawks and hummers, we have found that Goldfinches, Pine Siskins, domestic pigeons and great concourses of monarch

butterflies have been seen following the same route of migration, but never again the hummers.—W. E. SAUNDERS, *London, Ontario.*

Male Baldpate attending young.—On June 12, 1941, a male and female Baldpate (*Mareca americana*) accompanied by a brood of five young were seen on a large slough east of Amulet, Saskatchewan. Knowing that males of most ducks usually desert the females soon after incubation begins, a short notation was made of this unusual occurrence. Just west of Amulet, only enough time to eat lunch having elapsed, a brood of six young attended by both sexes was seen, the male definitely taking an interest in the care of the young.

A short distance westward, at the next slough, imagine my surprise at seeing a brood of eight Baldpates with only the male in charge. He led the young away, swimming slowly toward the opposite shore, but as I approached more closely, he seemed to desert the brood, flying toward a slough nearby; in flight he gave a series of trisyllabic, unmusical notes, best rendered as *tī-chück'-tīck*. A few seconds later he returned with the female, and it was she who led the brood to safety. The male followed his family, but gave the impression that he was relieved at turning over the responsibility to the female.

West of Horizon, Saskatchewan, a brood of nine Baldpates was seen, and again both male and female were in attendance. In this case the male began to feign injury, splashing the water with drooping wings, while the female led the brood away.

These four broods were the first observed in the 1941 season. Although I was in the field nearly every day from May 26 to August 29, 1941, and from May 30 to August 25, 1940, these were the only broods of the Baldpate seen where the drake was assisting in the care of the brood. All of these observations were made on one day, June 12, 1941, and all within a radius of about eight miles. Previous to this time Baldpates were seen in pairs, or males were seen singly.

It may be that the male is more likely to assist the female in caring for early broods, since the sexual instinct would be then better developed than later in the season, and since the moulting of flight feathers would not yet have forced the males into hiding. Possibly this aberrant behavior pattern has been developed in this restricted area to meet, or as the result of, some localized environmental factors.—ROBERT C. McCLANAHAN, *U. S. Fish and Wildlife Service, Washington, D. C.*

Ruby-crowned Kinglet as host of Cowbird.—On July 22, 1941, quite near my house at Scarboro Beach, Me., I heard a young bird calling loudly for food, and soon saw a tiny bird, not half its size come and feed it. Closer observation made me certain that the foster parent was a Ruby-crowned Kinglet, as it flashed its orange-red crown repeatedly; the dull brown, streaked young must have been a Cowbird. The kinglet was quite unable to satisfy the appetite of the huge fledgling, which kept after the tiny foster parent as though it would like to eat it, too. Dr. Herbert Friedmann in his 'The Cowbirds' (1929) states on page 256: "*Regulus calendula calendula*. A very rare victim [of *Molothrus ater*]. I have come across but one record. Davie writes that Mr. Montague Chamberlain records a nest taken at Lennoxville, Quebec, May 15, 1882 . . . It contained nine eggs, one of them a Cowbird's."—W. L. HOLT, *Scarboro, Maine.*

A probable case of parasitism in the Starling.—In May, 1940, I stopped at one of my many Bluebird boxes expecting to band young birds. When I lifted the hinged top, I was surprised to find a filthy nest with four half-grown Bluebird

babies (*Sialia sialis*) cuddled in the bottom. Above them was a two-thirds-grown Starling (*Sturnus vulgaris*), which was sitting complacently on the smaller birds below.

Normally a Bluebird box is immaculate, but in this case the droppings of the larger bird had soiled and in one case almost covered the head of one of the tiny birds below; one eye was entirely covered and there was a stench which is unusual about such a nest. I destroyed the Starling interloper, then removed the grass nest and the four immature Bluebirds. After cleansing the box, I rebuilt the nest out of clean dry bluegrass. The four baby birds were carried to a little creek where I washed them, thus removing the filth. After banding them they were returned to the newly made nest.

The female Bluebird soon returned, but was suspicious at first. Finally she accepted the altered nest and when I returned five days later the baby Bluebirds were ready to fly. Their bodies were well feathered and apparently they were well fed. I doubt if this Bluebird had laid her eggs in a nest that already contained a Starling egg, as normally such females construct a thin nest of grass over the eggs or nest of former occupants. I feel that the Starling egg must have been deposited during the process or after the full complement of Bluebird eggs was laid.

In the many years that I have carried on my Bluebird experiment, I have never before found a Starling roosting in or employing one of my boxes for a nest site. In fact, only upon three or four occasion have I found Cowbird eggs in the normal nest. Only when somebody has removed the top of a box thus allowing an approach of the female Cowbird through the aperture above has there been molestation on the part of the Cowbirds. Once under such conditions I found three Cowbird eggs associated with three Bluebird eggs. Never before has a Starling interfered with any of my five-hundred Bluebird boxes, although Starlings are commonly with us at all seasons.—T. E. MUSSELMAN, Quincy, Illinois.

RECENT LITERATURE

Beecher on vegetation and birds' nests.¹—This is a valuable study of the nest site as a key to population densities, based on the birds nesting on a 482-acre upland marsh area in northern Illinois. The local plant communities are described in detail, their succession illustrated, and their physical characteristics analyzed for their substrate value in nest construction. Beecher is the first to measure carefully the minute vegetational blocks in a large avian community and to furnish statistical confirmation of Leopold's law of dispersion. He finds that population density increases directly with the number of feet of edge per unit area of the plant society. It is also shown to be correlated positively with increasing floristic complexity of the environment in terms of communities per one-quarter of an acre. The author points out that the life form of plants has limitations as an index of population density; he finds the sod-forming of *Poa*, the hummock-forming of *Calamagrostis*, and the stout stalks of *Typha* of great importance. Data are presented on the vertical and seasonal distribution of the nests of fifteen species. Beecher concludes that the simultaneous nesting of marsh birds is conditioned by the development of the vegetation: laying may be retarded in spite of the physiological maturity of the gonads. Statistics on the nesting of seventy-two species in seventeen vegetational types are given. These afford a valuable quantitative clue to the relationship of nest pattern to the vegetational substratum.

Beecher's discussion of his results displays sound ecological thinking. The die-hard school of ornithologists may choke over the tribute paid to the Greeks, but the few terms of the bio-ecologists are happily defined in the opening chapter. (Sample: "Ecesis. Invasion.") The present report is almost too much a model of condensation. The edge effect is demonstrated for a number of species but the actual use made of it is seldom clear. To give the density of ten Robin nests in 7.08 acres of thicket would seem to the reviewer to tell only part of the story. The character of the adjoining fields should affect the density, depending on the degree of ecological services (feeding, bathing, etc.) which they offer.

This study represents several seasons of preliminary field work and is based on week-end observations in 1937, when some 1200 nests were located. About sixty-four of these were rails! The volume is a monument to amateur ornithology and a credit to the Chicago scientists who encouraged and aided the author. The book is attractively bound and printed but without an index. Its publishers can well be proud of this sound contribution to bird ecology.—J. J. HICKEY.

Behle on Western Horned Larks.²—The far western subspecies of Horned Larks are found to have various degrees of differentiation and stability, some wide-ranging and locally variable, others restricted and relatively more homogeneous. Each has a differentiation center where the most typical individuals occur, while away from this area the population is progressively less typical until it may gradually blend into the adjacent subspecies. Lesser trends may occur within the limits of a single subspecies. Mr. Behle found large intermediate populations for whose origin he prefers the hypothesis of intermediate geographical differentiation rather

¹ Beecher, William J. 'Nesting Birds and the Vegetation Substrate.' Chicago Ornithological Society, Chicago, 8vo, iii + 69 pp., 1 aerial photo, 10 text figures. 1942. Price \$1.00 (at the Book Shop of the Field Museum, Chicago, Ill.).

² Behle, William H. 'Distribution and Variation of the Horned Larks (*Otocoris alpestris*) of Western North America.' Univ. Calif. Publ. Zool., 46 (5): 205-316, figs. 1-13, May 20, 1942. \$1.25.

than that of hybridization, although he admits the probable existence of the latter process in certain cases and concludes that definite proofs of one or the other are lacking. He also considers the color of the soil to have been, and to be still, of considerable importance in the development of the various color differences since there is marked similarity in the dorsal coloration of the different subspecies and that of the soil on which they reside. The same condition may account for resemblances of distantly living forms to each other since the soil colors of their respective habitats are similar. Intensity of plumage color and humidity of climate also show correlation in general.

Separate origin of the two more recently described forms, *lamprochroma* and *utahensis*, in the dried up beds of two Pleistocene lakes is discussed to account for the existence of these two subspecies so near to each other. Much of the subspecific differentiation in the group is thought to have occurred since the Pleistocene. Isolation is conceded to have been an aid, but only an aid, in the speciation process, most effective when marked differences in environments exist or when environmental changes occurred simultaneously with the isolation.

The paper is well illustrated with distributional maps, and diagrams showing the individual, sexual and geographical variations of various measurements in the forms discussed. Molts and plumages and the ecological relationships of the Horned Larks are discussed and each form recognized by the author is treated in some detail.—J. T. ZIMMER.

Bent's 'Life Histories.'¹—This generous volume, the nineteenth of the series, begins the passerine birds and covers the four families listed in the title. As in previous numbers, Mr. Bent has culled information from a wide variety of sources, published and unpublished, to which he has added his own critical notes and observations. As before, much data and a few entire chapters have been supplied by various contributors to whom the author makes acknowledgement, but even with this assistance the amount and variety of material brought together is surprising. It is safe to say that no ornithologist, except the author of the volume, can read this work without learning many things new to him about the birds treated herein. Mr. Bent is to be congratulated on the passage of another milestone in his long task.—J. T. ZIMMER.

Birds around New York City.²—We have here a discussion in A. O. U. Check-List order of each species of bird known (or supposed in a few carefully considered cases) to have occurred in a New York City region (including Long Island and northern New Jersey). This is the area very thoroughly covered by keen and enthusiastic field students of birds, for whom the Linnaean Society of New York is a contact center. The region thus defined is treated as a whole.

A picture of each bird's distribution over the region is presented, its normal seasonal fluctuations in abundance, dates of arrival and departure if it is migratory, with abnormally early and late dates cited as such. If it breeds locally there is a statement of egg dates and number of broods. In estimating abundance, actual numbers which may be or have been observed in a day are given, and it is likely that this tangible data will be an even more interesting record in later years than at the time of writing.

¹ Bent, Arthur Cleveland. 'Life Histories of North American Flycatchers, Larks, Swallows, and their Allies.' U. S. Nat. Mus. Bull. 179, pp. xi, 555, pls. 1-70, 1942. \$1.00.

² Cruickshank, Allan D. 'Birds Around New York City, where and when to find them.' The American Museum of Natural History Handbook Series, No. 13, xvii + 489 pp., 35 pls., 1 map (end sheets), 1942. \$1.75.

The author's years of very active field observation in diverse parts of our region enable him to generalize from his own, and evaluate a mass of data from the records of the Linnaean Society and elsewhere which he has examined. In most cases a very satisfactory picture of the occurrence of the bird in question is presented. The correlation between fall migration and actual frost or freezing temperatures is probably overemphasized. These seem to be only one factor involved in a complicated pattern, and it is very questionable if carefully compiled statistics would bear out such correlations too well. A greater or more extended familiarity with certain included areas suggests some minor modifications of statement, and reminds us that the book is another stepping-stone, something to test and build on. The treatment of species whose movements are abnormal or complicated is less satisfactory than of others. A slight tendency is apparent to regiment them into a mould where they do not quite belong.

One can find statements which, if not erroneous, are somewhat misleading, such as that the Scarlet Tanager is noticeably scarce to unknown as a breeder even in ideal woodlands on the south shore of Long Island. Perhaps it is a reaction against the sanctity of the collected specimen, in a mostly field-glass observer, that leads the reviewer to call attention to Burggraf's cited winter specimen of the Migrant Shrike, which he examined hoping to substantiate the winter record, but found to be a rather small bird in the characteristic brownish, barred plumage of the winter immature Northern Shrike, as reported to the Linnaean Society at the time.

In the introductory chapters which precede treatment under species, in one on various habitats called 'ecological blocks,' dominant and sub-dominant birds are listed for each,—summer, spring and fall, and winter. This seems to the reviewer principally interesting in method, a method which might bring out significant facts in a better delimited field, but means little as here applied over so varied an area to a heterogeneous and poorly analyzed avifauna.

Under 'Seasonal Variation' the local birds are divided into groups by seasons with excellent judgement. Those called "casual or accidental," however, though they are rarely identified near New York, differ widely from one another in local status.

'The Ornithological Year,' the rise and fall of local bird life followed month by month, is an exceedingly clear, true, and well-written picture.

The attempt to establish the normal gives a valuable background for analysis of occurrence, and migration dates, but no attempt is made at real analysis of such data, that which might bear on the subject being frequently set aside as of no consequence. The word casual is used so freely that it is robbed of a specific meaning. Perhaps we have reached a point where no single volume will suffice for full discussion of the local avifauna.

Having examined 'Birds Around New York City,' perhaps too critically, it remains to say that it is an exceedingly attractive volume, full of previously unpublished information, to which we will all have frequent occasion to refer. It reflects not only the author's field experience and knowledge of local birds but something of his dynamic personality, and can be read with pleasure from cover to cover. The numerous photographs of birds in nature with which it is illustrated are chosen for their beauty. The reviewer's favorite is the Hooded Merganser drake, but each reader must suit himself.—J. T. NICHOLS.

Birds of southeastern Georgia.¹—This little work presents an annotated list of the birds of these two extensive areas of swamps, based principally on the author's own observations over a period of years but including also notes by a variety of other observers. Dates of occurrence of the rarer forms, local distribution, behavior, and such matters are given 'attention in varying degree. Local vernacular names of many of the species are added. An 'Okefinokee Shooting Record' for the years between 1926 and 1935, inclusive, shows the fluctuating abundance of the various species of ducks, the snipe, and the woodcock. A glossary of local topographical terms is appended and detailed sketch-maps show the configuration of the terrain. The list should form a useful basis for future work in the area.—J. T. ZIMMER.

An ancient bestiary.²—Although of primary importance to the bibliophile, medieval 'bestiaries' are historically interesting to zoologists as showing early stages in the development of the illustrated natural history and also demonstrating the antiquity of certain of the myths about animals, some of which still persist. The ancient and unique volume discussed in the present treatise occupies an important place in the family tree of this class of books and also throws new light on an old technique of quantity production of text and illustrations. It appears to have been prepared as a model for a proposed 'edition' of which no final copies are now known to exist. Several interesting conjectures with reference to this work are discussed.—J. T. ZIMMER.

Structure and function in scansorial birds.³—A woodpecker, a woodhewer, a nuthatch, a creeper, and a wren were critically examined to determine what structural modifications are held in common that are lacking in other birds without such habits. Such modifications were found only in the legs and feet except that when the methods of feeding and climbing are similar in detail in some of the birds studied, further similarities are noticeable in these particular cases. Thus the species that use the tail for support, like the woodpeckers, woodhewers, and creepers, but not the nuthatch and wren, have several features of tail-structure in common. The creeper and woodhewer which use their bills in similar manner have comparable modifications of the bill. All of them have adaptations for clinging to the sides of the trees—structural modifications to increase the leverage of particular muscles, devices to give more effective control of the claws, lengthened foreclaws, etc. These are largely primary adaptations formed by the modification of existing structures. Some preadaptations are noted but were found to be not easily recognizable; the short leg and zygodactyle foot of the woodpecker are considered as probable preadaptations since they occur in various non-climbing picoideans. Incidental adaptations were not recognized as such in the study. The comparable structures were found to be homologous in every case and the adaptations are therefore classed as parallel rather than convergent. The study is an important contribution to the knowledge of the correlation of form and function.—J. T. ZIMMER.

¹Hebard, Frederick V. 'Winter Birds of the Okefinokee and Coleraine. A Preliminary Check-List of the Winter Birds of the Interior of Southeastern Georgia.' Georgia Society of Naturalists, Bulletin No. 3: 84, X, 3 maps, December, 1941.

²Ives, Samuel A., and Lehmann-Haupt, Hellmut. 'An English 13th Century Bestiary. A new discovery in the technique of medieval illumination.' Pp. 1-45, figs. (plate) 1-5, 1942; H. P. Kraus, New York. \$1.85.

³Richardson, Frank. 'Adaptive Modifications for Tree-trunk Foraging in Birds.' Univ. Calif. Publ. Zool., 46 (4): 317-368, pls. 23-24; 16 text-figs., May 26, 1942. 75 cents.

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CORRESPONDENCE

'HABITS' AND 'BEHAVIOR'

EDITOR OF 'THE AUK':—

In the literature pertaining to life history studies of birds and other organisms there is frequent use of the term, 'habit.' As thus used, the habits of birds include all observable types of behavior in the field. There is much to be said in defense of the use of this term, particularly in regard to its propriety according to prolonged usage.

But the present trend in ornithology toward detailed studies on bird behavior, with the employment of modern psychological terms such as 'stimulus,' 'reflex,' 'releaser,' etc., makes it seem worth while to reexamine our usage of the term 'habit.' In the restricted modern sense, psychologists define 'habit' as an 'acquired motor pattern.' Such behavior in birds is difficult to observe and describe in the field. It is advisable, therefore, that we substitute the term 'behavior' for 'habit' wherever it appears without specific qualification in ornithological manuscripts.

While considering this point, one may well ask whether 'habitat' is also an inaccurate term. According to Webster's Dictionary, however, this word has a different derivation from 'habit.' Thus 'habit' comes from Old English *habīt*, *abit*, from Latin *habitus* state, appearance, dress, from *habere* to have, be in a condition; probably akin to English *have*. But 'habitat' comes from Latin, it dwells, from *habitare*. Thus there is no overlapping in the roots of the two terms, and we may quite properly study the behavior of birds in their habitats.

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'DUCK HAWK IN OHIO'

EDITOR OF 'THE AUK':—

In the General Notes section of 'The Auk' for April, 1942, page 306-7 is an item titled 'Duck Hawk in Ohio' by Hubert Bezdek, Ohio Division of Conservation and Natural Resources, Batavia, Ohio. The purpose of the note as stated by its author is: "Records of the Duck Hawk in Ohio are sporadic and scattered and it is therefore the intent of this paper to combine as many of these as possible besides the addition of new records." After an account of a specimen taken Oct. 4, 1940, in Clermont County, Ohio, he writes: "The following are *most* of the Ohio Duck Hawk Records:" (*italics inserted*). He then concludes with a table of occurrences.

Of the dates of occurrence, those on July 31, 1930; Jan. 19, 1932; May 30, 1937; Oct. 9, 1939; and Oct. 24, 1939, are taken from 'The Birds of Lucas County' [Ohio] (L. W. Campbell, 1940, p. 59). In treating the Duck Hawk in this work, I made the following statement: "Since 1927, notes from local observers give the total occurrences of this uncommon transient as twelve times in spring and about forty times in fall.—These data also include birds in the Erie Marsh, Michigan." (The Erie Marsh borders the state line.) Following this I mentioned several dates specifically to indicate wintering individuals, summer individuals, a banded individual, etc. It is these dates only which Mr. Bezdek has listed.

Furthermore, in Appendix "B," I have shown the earliest date of arrival and the latest date of departure for this species for both spring and autumn and the averages for these extremes. These data are based on six years in spring and nine in autumn.

In reporting only a portion of my material on the Duck Hawk, Mr. Bezdek has created a completely erroneous impression of the status of this species in Lucas County.

LOUIS W. CAMPBELL

Toledo, Ohio

Long-billed Curlew on the Atlantic coast; a correction.—In the last number of 'The Auk' (July, 1942, Vol. 59), in our "Bird records from Virginia," we recorded a Long-billed Curlew on Rogue Island and said that this was the first record for the bird on the Atlantic Coast since 1923. Alexander Sprunt, Jr., and Francis H. Allen have called to our attention, however, that this is incorrect. There have been many published records of Long-billed Curlews since 1923. Mr. Sprunt tells us that they are not at all uncommon on the coast of South Carolina and Georgia.—WILLIAM MONTAGNA and WILLIAM A. WIMSATT, *Cornell University, Ithaca, N. Y.*

OBITUARIES

DR. CASEY ALBERT WOOD joined The American Ornithologists' Union in 1917, was elected to the class of Members in 1921, and so continued the remainder of his life. He died in La Jolla, California, January 26, 1942. Probably only prolonged periods of absence from this country prevented him from being made a Fellow as he was in every way qualified. Born of American parents in Wellington, Ontario (November 21, 1856), educated in Canada and Europe, and after his professional career in England and the United States, visiting and residing in any part of the world he chose, Dr. Wood was an international, rather than a national, figure.

His professional career in ophthalmology included service in New York, London, and Chicago. In the last city he also taught the subject successively at the Post-graduate Medical School, the College of Physicians and Surgeons, Northwestern University, and the University of Illinois, where he was head, and later emeritus, professor. During the first world war he was in active service as a first lieutenant for a few months, then in turn was major in charge of examination of candidates for aviation and the signal corps at Chicago, in charge of the eye department at Camp Sherman, Ohio, and lieutenant-colonel on the staff of the surgeon general at Washington. After the war he was retired to the reserve with the rank of colonel. Dr. Wood was editor of the *Annals of Ophthalmology* (1894-1901), the *Ophthalmological Record* (1902-1908), and the *American Journal of Ophthalmology* (1908-1914); he was associated also with the editing of other magazines, and contributed to, and prepared as a whole, 'systems' and textbooks in this field.

In an ornithological direction, this phase of Dr. Wood's work culminated in 1917 in a treatise on 'The Fundus Oculi of Birds, especially as Viewed by the Ophthalmoscope; a Study in Comparative Anatomy and Physiology.' This was a folio, illustrated by 145 drawings in the text and 61 colored paintings reproduced as plates; "a most important monograph on the eyes of birds."

Most of the subsequent ornithological writings of Dr. Wood were by-products of his travels and hence relate chiefly to exotic birds. A complete list of them prepared by Margaret Hibbard, Librarian of the Wood Library, is included in the biography prepared by Colonel Edgar E. Hume in his recent welcome volume on 'Ornithologists of the United States Army Medical Corps' (Johns Hopkins Press: 476-490, figs. 90-96, 1942—one a portrait, another a photograph of a sculptured head). Dr. Wood's travels were not haphazard sightseeing expeditions but well planned and industriously executed searches for specific facts or things—particularly the latter. Books and manuscripts, original paintings and drawings, as well as appropriate personalia were the objects of his quest. Going direct to the best sources, he was personally instrumental in building the excellent Blacker Library of Zoology, called after the friends (Mr. and Mrs. Robert Roe Blacker) who helped furnish the funds, the Emma Shearer Wood Library of Ornithology, named for his wife, and other libraries at McGill University. The memorialist is no judge of the collections in other fields, but he ventures to say that those in ornithology are unexcelled at any other single institution in North America.

Dr. Wood compiled and edited a monumental record of the results of his collecting in 'An introduction to the literature of Vertebrate Zoology' (Oxford University Press, xix + 643 pp., 1931); this is now incomplete as the libraries

involved have continued rapidly growing. Nineteen chapters preceding the actual catalogue of publications in this work evidence a comprehensive knowledge of the history and purport of zoological literature. Doctor Wood was exceptionally erudite and with him education never ceased—nor did production. With his last strength he made arrangements for the publication by the Hanford University Press of a reproduction and translation (in collaboration with his niece Marjorie Fyfe) of 'De Arte Venandi cum Avibus' by Emperor Frederick II of Hohenstauffen (1194–1250), together with various accessory chapters. This was largely the product of a final ten years of work, chiefly at Rome and in the Vatican Library. There he made this and other translations from mediaeval Latin, and others from Arabic. In earlier years he had published translations from German, French, Italian, and Spanish.

All in all, the subject of this sketch was probably the most broadly cultured and deeply learned of his generation in our Union. He was fond of poetry and in 1920 published in collaboration with Fielding H. Garrison 'A Physician's Anthology of English and American Poetry' (Oxford University Press). He could appreciate also the lighter side of life and wrote for, and supported, our well known informal organ—"The Auklet."

His niece writes of his last days, "It was amazing how, ill as he was, he still impressed people with the force of his personality. . . . I don't think he ever suffered, and all through his illness he showed no sign of distress. His sense of humor stayed with him until the last. . . . He gradually grew weaker and finally just went to sleep."

Accounts of Dr. Wood are in all of the leading biographical directories; the following memorials also may be cited: W. W. Francis, *Journal of the Canadian Medical Association*, 46: 296, March, 1942; and Burton Chance, *American Journal of Ophthalmology*, 25: 607, May, 1942.—W. L. McATEE.

ROBERT W. HEGNER (1880–1942).—On the eleventh day of March of this year, ornithologists lost one of their most distinguished colleagues. Robert W. Hegner, known and honored for his contributions to biology, zoology and ornithology, was born sixty-two years ago on February 15. His interest in the study of birds was evidenced early in his student days. At the turn of the century, lantern slides that he developed from his collection of unique bird photographs were paying his way through the University of Chicago. One of his original tricks was to photograph nests inside tree trunks by means of mirrors. A number of his early pictures were published in *Bird-Lore*, in other nature magazines, and in newspapers. His recent book, 'Parade of the Animal Kingdom,' contains many of these early photographs as well as some made in more recent years.

Dr. Hegner was an ardent egg collector as well. His entire collection, gathered mainly in the vicinity of his boyhood home of Decorah, Iowa, was given to the University of Michigan while he was a member of the faculty of that school. Dr. Hegner was an associate member of The American Ornithologists' Union from 1901 to 1904 and, though his teaching duties in other branches of zoology forced him to give up his active part in ornithology, he never lost interest in the field. Since 1918 Dr. Hegner had been associated with the School of Hygiene and Public Health of the Johns Hopkins University and since 1922 had been professor of protozoology.

Along with his well known and widely used textbooks on college zoology and other academic subjects, Dr. Hegner is to be remembered for his contributions

to research on malaria and other parasites of birds. Much of our current knowledge of this field in North America was developed and published by Dr. Hegner and his students. Bird parasite problems, particularly malaria, continue to be studied by Dr. Hegner's students and it is their hope that their progress in the years to come will be worthy of the initial efforts of the teacher they so humbly revered. His published works and the profound effect of his inspired teaching upon his students will remain a lasting memorial.—CARLTON M. HERMAN.

PHILIP BERNARD PHILIPP, a Life Associate of The American Ornithologists' Union, died in New York City on July 11, 1941, at the age of 63. A graduate of Harvard University and of Columbia Law School, he was until a few years before his death a partner in the patent law firm founded by his father. Mr. Philipp made a lifelong hobby of collecting birds' eggs. He was, however, keenly interested in birds and bird photography as well as eggs and was always anxious not only to avoid the collecting of eggs of threatened species but to take active steps for their protection. He wrote a few of the educational bird pamphlets published by the National Audubon Society and for twenty years was president of the New Jersey Audubon Society. Philipp collected in many of the eastern states and also, over a period of years, at his camp in northern New Brunswick. At the latter locality he obtained much valuable information on the hitherto almost unknown nesting habits of such species as the Cape May Warbler and Philadelphia Vireo. This he published in several articles ('The Auk,' 1916, 1917, 1919; 'Canadian Field Naturalist,' 1925) written in co-authorship with his field companion, Mr. B. S. Bowditch. The accurate and copious field notes which accompany his specimens are an additional source of valuable information to students of life history.

To supplement his own field work, Philipp, by purchase and exchange, built up his collection of North American eggs until it numbered almost 7000 sets and was one of the most complete in existence. In 1937 he presented his entire collection to the American Museum of Natural History together with the necessary means to permit not only his but the entire oölogical collection of the museum to be properly installed in the new quarters which became available at about that time. He was appointed a Research Associate at the museum and undertook his new activities with his characteristic keen enthusiasm. Unfortunately a serious decline in his health soon compelled him to give up all except occasional visits to the museum. His disappointment was lessened by his realization that his collection was now permanently available for educational and scientific projects.—DEAN C. AMADON.

PROFESSOR FRANK SMITH of the University of Illinois was an Associate of The American Ornithologists' Union from his election in 1909 until his death at St. Petersburg, Florida, February 3, 1942. Born at Winneconne, Wisconsin, February 18, 1857, he had attained a venerable age. He earned money to pay for higher education chiefly by teaching; graduated from Hillsdale College, Michigan, in 1885; later worked in marine biological laboratories at Annisquam, Massachusetts, and Newport, Rhode Island; and did graduate work at Harvard University, where he received the A.M. degree in 1893. In 1892 he taught biology in Trinity College, Hartford, Connecticut, and in 1893 went to the University of Illinois as instructor in zoology. He rose steadily through the faculty grades becoming Professor in 1913. He was also Curator of the University Museum of Natural

History, 1900-1917. The honorary degree of D.Sc. was given him in 1923 by Hillsdale College, and in 1926 he retired from the University of Illinois as Professor Emeritus. In the rather long period of retirement (16 years) vouchsafed him, he lived chiefly at Hillsdale, Michigan, in summer and at St. Petersburg, Florida, in winter.

With a mathematical bent at first, his life-work was in zoology. While diverse, it was sufficiently concentrated upon the earthworms and their allies that he may be fairly said to have created the classification of these animals for North America. He also published on the earthworms of other lands and was a leading authority on fresh-water sponges. His printed contributions to ornithology (13 in number) relate principally to migration. He endeavored to stimulate and guide migration study in Illinois and to summarize the results.

This interest continued after his retirement when he carried on bird study at both his Michigan and Florida homes. He was a faithful attendant of the meetings of the St. Petersburg Audubon Society and of the Florida West Coast Bird Club. Those who have commented on Professor Smith's personality have emphasized his sincerity and thoroughness, modesty and helpfulness. 'Who's Who in America,' and 'American Men of Science' may be consulted for biographical details and 'Science' 95: 398-400, April 17, 1942) for a memorial by Paul S. Welch. For facts about Professor Smith, the present writer is indebted to Dr. Welch and also to William G. Fargo, Alice S. Johnson, H. R. Mills, Daisie M. Morrison, Francis M. Weston, and Harley J. Van Cleave.—W. L. McATEE.

NOTES AND NEWS

'The Auk' takes great pleasure in announcing a generous gift from Life Associate, Edward A. McIlhenny of Avery Island, Louisiana, who has made a liberal pledge of \$150.00 quarterly for a period of five years to aid in the publication of this journal. Needless to say, this gracious and unexpected gift furnishes a most welcome addition to our publication fund where it is badly needed. The membership of The American Ornithologists' Union in general and the Treasurer and Editor in particular have reason to be very grateful to Mr. McIlhenny who has shown himself a true friend of the Society with which he has been associated for nearly fifty years.

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